Tappi

PUBLISHED BY THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY

SEPTEMBER 1952

PEXOL* FORTIFIED SIZE

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Now, for the first time, a fortified rosin size containing 77% solids, instead of 70%, is available to the paper industry. This higher solids Pexol offers additional advantages of greater ease in handling and in use. Pexol's efficiency in lowering size costs for every ton of paper or board produced is even higher than before, because of increased freight saving.

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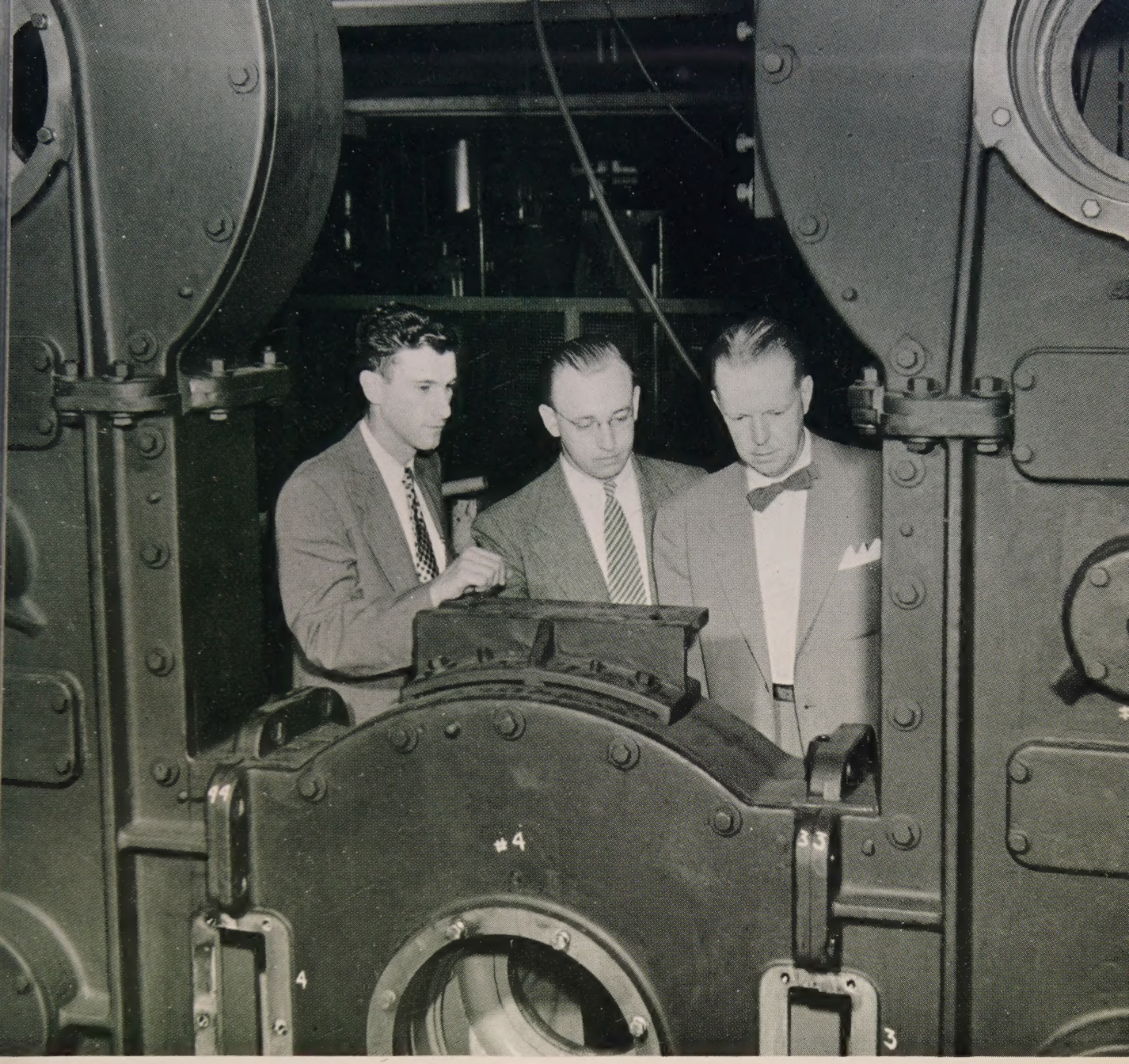
SIZING MATERIALS AND CHEMICALS FOR PAPER



ENCLOSED DRYER DRIVE with gear nips "running in oil" makes possible cleaner, quieter operation at higher speeds. While looking at dryer framework ready to be shipped to a mill on the West Coast, "Bud" Hammill (*left*), E. J. Justus and Sterling Skinner discuss Beloit design features which provide for continuous lubrication and simplified removal of dryer bearings.—*Beloit Iron Works, Beloit, Wisconsin.*

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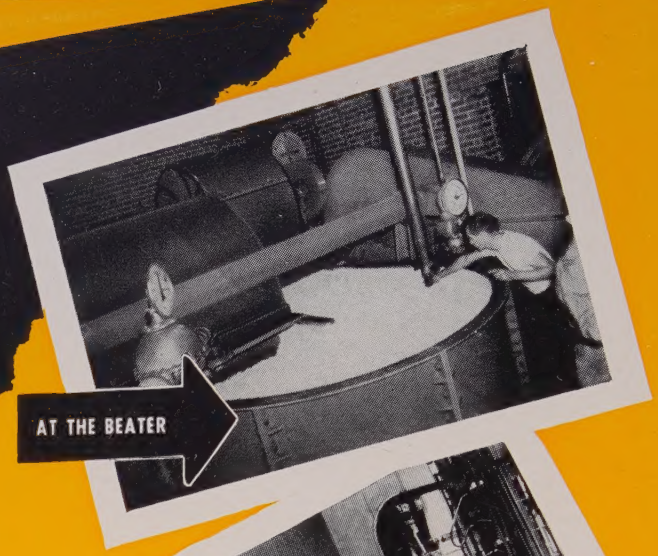

From beater to calender stack, sizing needs are most effectively met by Nopco Wax Sizes. Developed to assure positive wax retention on the fibers, and even wax migration through the sheet, these scientifically-developed paper chemicals mean high sizing efficiency at low sizing cost.

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Details of application were:

Stock 40 lb. basis weight (24 x 36–500) medium beaten Scandinavian unbleached kraft pulp (results depend greatly on type of stock used).

Production Latex as received was added to the beaten pulp without any special sensitizing process. Alum precipitated the rubber onto the paper fibers. No expensive solvent recovery system or heat treating equipment was required. Regular equipment was used with no plugging of screens or other difficulties.

End Results Edge tear improved up to 40% over non-impregnated stock. Improved drape and soft, flexible feel imparted to heavy kraft. No stiffness or boardy feel. Stock has cloth-like, rubbery stretch.

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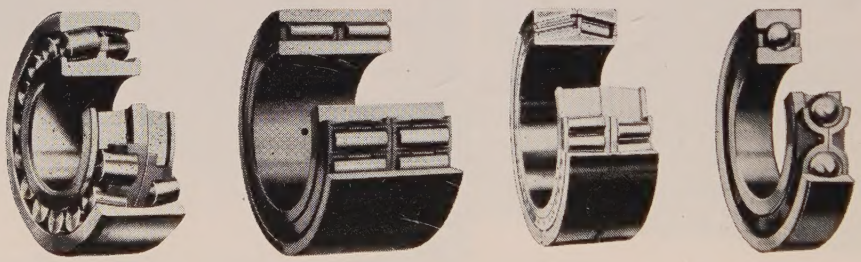

Torrington engineers have a thorough knowledge of the friction problems encountered in virtually every type of mechanical equipment. And they have had many years of experience with *all* types of anti-friction bearings. They are able to give sound, unbiased recommendations for the bearings best suited for the job at hand. Result: a harmonious blending of anti-friction bearing types with the products in which they are used.

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SEPTEMBER 1952

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TECHNICAL ARTICLES

Flow in "Converging Nozzle" Type Slices—Can Negative Pressure be Present? *by J. B. Gough* 385

Final Report—Press Section Load Requirements, *by R. R. Baker* 390

Ozone Purification of Water, *by Victor Hann* 394

Development of Design Data for Corrugated Fiberboard Shipping Containers, *by K. Q. Kellicutt and E. F. Landt* 398

Corrosion of Alkaline Pulping Digesters—Analysis of Corrosion Questionnaires, *by R. S. Peoples and G. L. Ericson* 403

Effect of Alum on Slime Formation in Board Mill Stock, *by Willem Rudolfs and Nelson L. Nemerow* 410

Case Studies in the Application of Industrial Statistics to Papermaking, II, *by Charles A. Bicking and Richard T. Trelfa* 413

The Determination of Starch in Paper, *by B. L. Browning, L. O. Bublitz, and R. S. Baker* 418

Particle Size of Clay, Its Determination and Effects, *by F. E. Masterman* ... 420

Effect of Chip Size in Alkaline Pulping, *by W. J. Nolan and W. F. Brown* ... 425

DEPARTMENTS

Technical Problems of the Pulp and Paper Industry ..... 14 A
Coal and Ash Handling, *by Donald M. Given, Jr. and Carl A. Marshall* ..... 40 A
Association News and Events ..... 71 A
Recent Books ..... 74 A
Personal Mention ..... 78 A
Obituaries ..... 100 A
Local Section Activities ..... 102 A
Reports and Discussions ..... 119 A
United States Patents on Papermaking:
Second Quarter, 1952, *compiled by Clarence J. West* ..... 154 A
Trend of the Pulp and Paper Market ..... 161 A
The Barking of Turkey Oak, *by R. L. Harvin, W. J. Nolan, and Wilson F. Brown* ..... 164 A
The Nature of Odor, *by Ernest C. Crocker* ..... 169 A
TAPPI Standards
Moisture in Paper and Paperboard, Proposed Revision of TAPPI Official Standard T 412 m-42 ..... 176 A
Employment Service ..... 177 A
TAPPI Fibrary ..... 178 A
Instrumentation Studies. LXXIV. Determination of the Bonding Strength of Paper. IV. Progress Report on the Development of a New Method and New Instrument, *by W.A. Wink, Thomas J. Clinton, Richard W. Thickens, and J. A. Van den Akker* ..... 181 A
Calendar of TAPPI Meetings ..... 189 A

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ANSWER:
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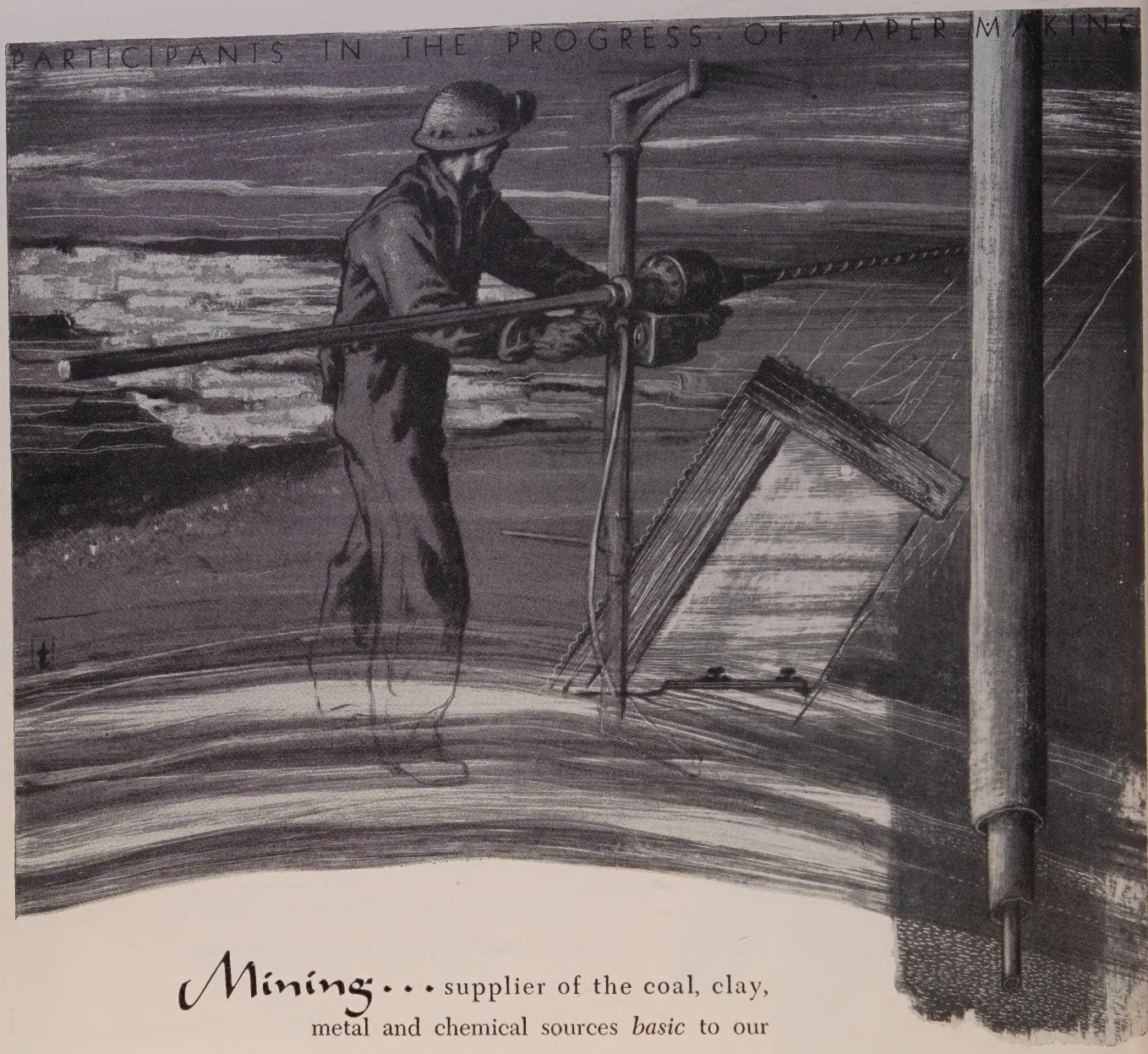

Mining . . . supplier of the coal, clay, metal and chemical sources *basic* to our national economy . . . *vital* to the paper industry.

Fourdrinier Wires . . . vital, also, to the paper industry, have received at Appleton Wire Works, Inc., the intense focus of 56 years of experienced research . . . resulting in the *earned* acknowledgement that *"Appleton Wires are Good Wires!"*

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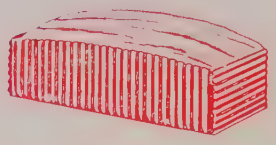
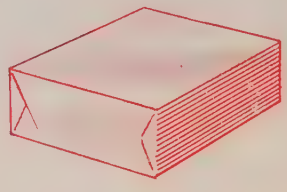
WHEN IT'S RELEASE YOU WANT IN PAPER

Du Pont "Quilon" is the answer!

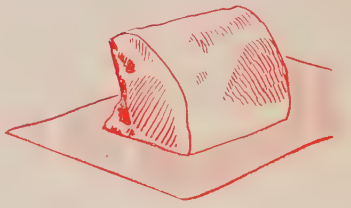
For rubber-separator papers, pressure-sensitive tapes and labels, "Quilon" makes possible easy stripping.



For bakery tray and pan liners, "Quilon" greatly reduces sticking of baked goods.



For frozen-food packages and locker wrap, "Quilon" eliminates fiber pull when frozen-food packages are separated and when frozen food is removed from wrap.



For butcher's wrap and meatboard, "Quilon" reduces sticking, keeps paper from tearing when unwrapped.

When you treat paper with Du Pont "Quilon" stearato chromic chloride, you give it release qualities of unusual functional value. Yet the cost is low because the amount of "Quilon" needed is so small. And the treatment is permanent because "Quilon" is non-migratory—anchors tightly to the fibers of paper.

"Quilon" is water-soluble and easily applied by spray, transfer rolls or immersion. Treatment can be done at the size press or, for heavyweight papers, at calender stack water boxes. "Quilon" doesn't give paper a waxy feel . . . doesn't adversely affect any dry properties of paper.

"Quilon" also provides outstanding water repellency and size

"Quilon" can be used to impart a high degree of size and water repellency to paper. And as a pre-treatment for wax-coated paper, "Quilon" increases lactic-acid resistance. It also has wide application for minimizing undesirable water sensitivity of many soluble coatings and adhesives.

Improved products, greater sales. The novel properties and amazing versatility of Du Pont "Quilon" may help you increase your sales of standard products or make superior new products. Send for the technical bulletin . . . it gives more facts and figures on uses and methods of application.

"Quilon" is a registered trade mark of E. I. du Pont de Nemours & Co. (Inc.)

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150th Anniversary

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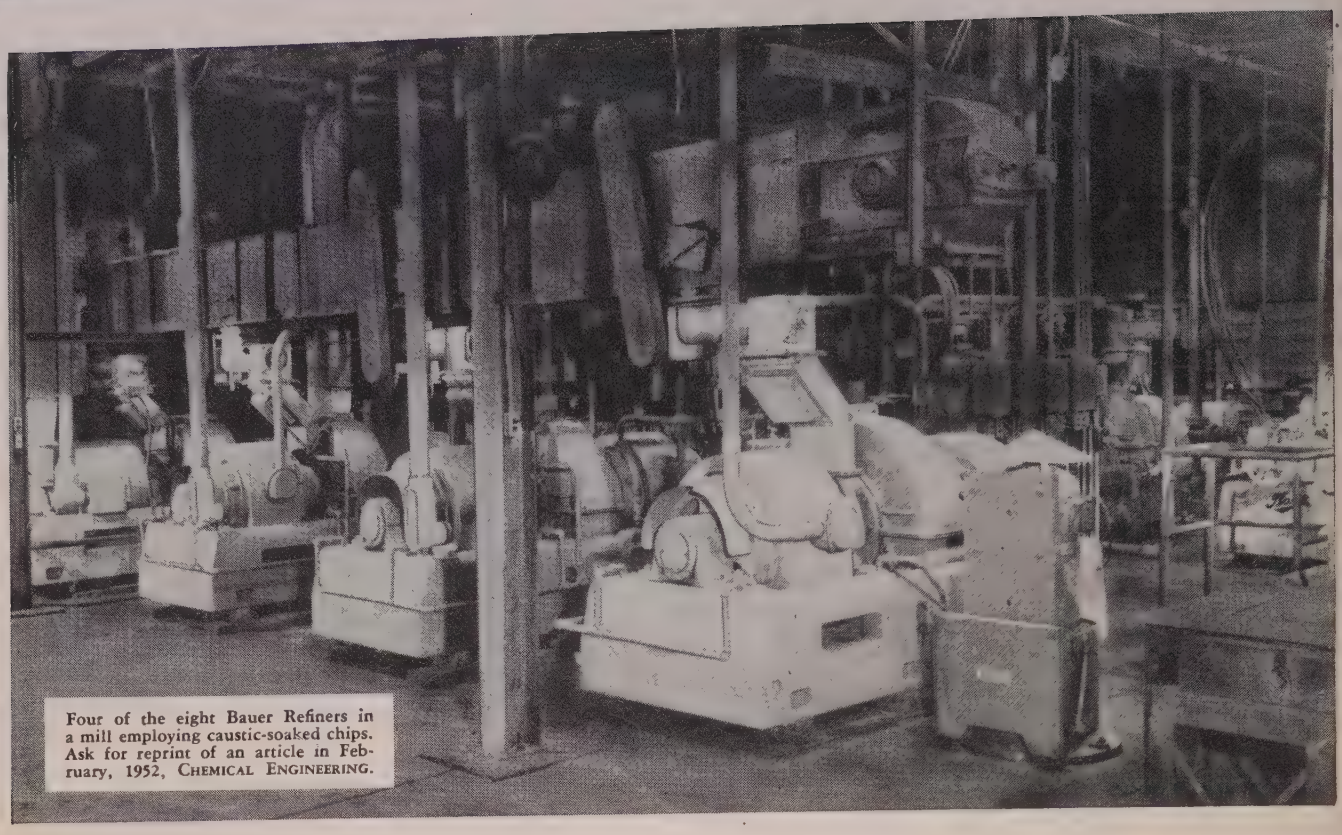

Four of the eight Bauer Refiners in a mill employing caustic-soaked chips. Ask for reprint of an article in February, 1952, CHEMICAL ENGINEERING.

Actions speak for Bauer Disk Refiners

When end products and manufacturing costs are compared, the evidence wins the case for disk refining. The proof of actual performance accounts for the increasing usage of Bauer Disk Refiners.

These machines produce unique fiberizing and dispersing results through brushing and rolling manipulations combined with vigorous agitation and turbulence. The effects are seen in final paper or board of improved appearance and greater strength.

The materials being processed with Bauer Disk Refiners include raw, steamed and semi-chemically-cooked chips; groundwood; knotter and screen rejects; waste paper stocks; bagasse; rags; straw, and various other agricultural residues.

The foregoing materials are fabricated into tissues; book, bond, and bag papers; newsprint, wrappers, all types of container board, insulating and building boards, roofing felts, etc.

We'll be glad to show you mill samples as evidence of the work done by Bauer Disk Refiners. In case you wish to try new materials, our research laboratory is at your service for test runs on commercial machines.

You are invited to communicate with us or confer with our sales engineers.

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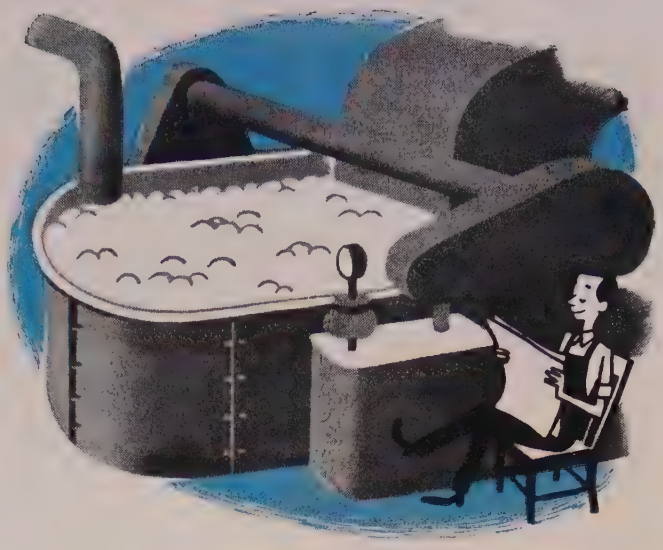

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Two outstanding performers in the darker range are Paper Product 2274—a liquid size and Paper Product 2284—a dry size. These non-foaming dark sizes offer worth-while economy in kraft and paper furnishes where whiteness is not important.

Your Cyanamid representative will be glad to give you full details on how ACCOBRITE can improve sizing operations.

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SOUTHERN EXPANSION

to keep pace with demands

Above: General view showing construction during expansion program at St. Regis Paper Company's Cantonment, Florida plant.

Left: Three 30 ft. diam. by 20 ft. liquor tanks and a 20 ft. diam by 35 ft. foam tank.

THE pulp and paper industry in the South has been forced to expand rapidly to keep up with the ever-increasing demand for its products. One extensive expansion program now being completed is that of the St. Regis Paper Company at Cantonment, Florida.

Structures built by Chicago Bridge & Iron Company in the St. Regis program include seven new digesters, 10 ft. 6 in. in diam. by 40 ft. high; a blow tank, 24 ft. in diam.; three 30 ft. diam. by 20 ft. liquor tanks; a 20 ft. diam. by 35 ft. foam tank; a Horton accumulator, 20 ft. in diam.; various stacks; and other steel plate equipment such as hot water, surge and sump tanks.

Our facilities for designing, fabricating and erecting steel plate structures are complete. Four large plants in Birmingham, Chicago, Salt Lake City and Greenville, Pa. are strategically located to provide efficient service. Write our nearest office for complete information.

Above: 30 ft. diam. by 20 ft. weak liquor tank built by Chicago Bridge & Iron Company for the St. Regis Paper Company at Cantonment, Florida.

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Los Angeles, 17 . . 1550 General Petroleum Building
New York, 6 . . . . . 3324—165 Broadway Building
Philadelphia, 3 . . . 1642—1700 Walnut Street Building
San Francisco, 4 . . . . . 1538—200 Bush Street
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Charles Worzel

—A "Weigh" to Better Wires

Responsible for weighing up metals for our melting furnaces, Charles Worzel knows that upon his accuracy depends the fine quality of fourdrinier wire... wires, and of copper and zinc that make up our brass wi...

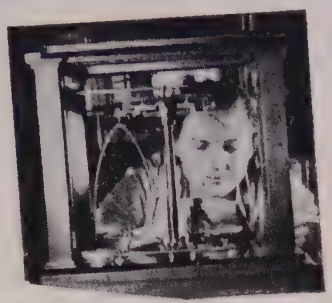
One of the Women Behind Eastwood Wires

Muriel Abrash

Operates on a "Small Scale"

On an over-all basis, we operate on a large scale, considering that we ...alloys, cast our own ... own determining the correct analysis of alloys for every type of warp and shute wire.

Here in the laboratory is the heart ...wood's manufacturing philos... + Control +



One of the Men Behind Eastwood Wires

Chester Mankiewicz

Here we show a fine-wire drawing machine being threaded or "strung up." The finished sizes are going through their final drawing in a special lubricant and coolant, then onto spools for use as warp or shute wires.

What began as a one-foot length of ... 2,200 foot length of fine ... Expert ...

EAS

One of the Men behind Eastwood Wires

James Dorney

Whose work is always "on the beam"

...f wire you see in the ...ound onto be filled at a time. After this back beam is filled, each warp wire must be threaded through guides leading ...ont of the loom, where the ... place. This is ...king

Two of the Men behind Eastwood Wires

Michael Finn and Charles Zindel, Jr.

Teaching and Learning the Art of Weaving

The unerring hand of Michael Finn, journeyman weaver, deftly guides each tiny thread of wire into its rightful place while "dressing" a loom.

This is a task so painstaking that ... may be two weeks ... sary for this job are also required for the fine art of passing the technique on to others.

Our Apprenti... ...

EA

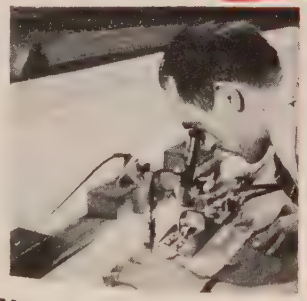
One of the Men behind Eastwood Wires

Robert Zimmerman

"Seaming-ly" at Work

The supervisor of our seaming department is shown operating a brazing machine across a fourdrinier wire, the ends of which previously ... last the rest of the wire.

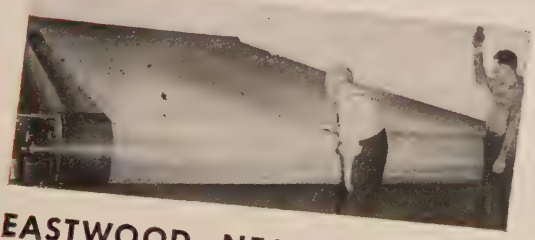
Seams once made by hand were a major source of complaints. Today —because of the brazing machine developed by the Eastwood organi... ...bles have been



Two of the Men Behind Eastwood Wires—John Lancaster and Clarence Reed

TEAM UP FOR THE "BIG STRETCH"

E



Here is a fourdrinier wire getting its final conditioning on the "stretching table". Only molten metal, *centrifugally cast*, weeks ago in our foundry, the many and varied skills in our large, completely integrated plant have transformed the alloys into a uniformly-woven wire that will enable some fine mill to maintain its reputation for top-quality paper.

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THE MEN BEHIND YOUR FOURDRINIER WIRE

We know them well-
We call them by their first names
We know their skills
We share the same ideals, the same pride in producing the best wires that good men and good machines make possible

Technical Problems of the Pulp and Paper Industry*

Suggestions Indicating Important Research Problems

THE pulp and paper industry is tremendously ramified in its technology, both as regards its processes and its products. Similarly, its basic, unsolved, technical problems are complex. Undoubtedly, other industries can make the same statement about themselves. Industries tend to view their own situations as being unique—they tend to segregate themselves in building their technology, terminology, and technical associations, and in solving their own problems. Yet, *fundamentally* (speaking in the scientific sense), many industries have common technical problems.

Similarly, many scientific educational institutions, in their teaching and research, draw examples or problems from industries most familiar to the teachers. Undoubtedly, in many cases these examples or problems, with but slight revision, would reside in another industry. Solutions for one industry would be largely valid for another.

Recognizing this situation, and in the hope that, to some other industry, or to some scientific institutions, some of its technical problems may be of interest (or may already have been essentially solved), the pulp and paper industry has compiled the following descriptions of some of its more pressing technical problems.

To those who are unfamiliar with the pulp and paper industry, the following brief lay description of the sequential processes of the industry may be helpful.

Wood is the basic raw material of the pulp and paper industry, although paper is made from the fibers of many other plants, such as cotton, flax, hemp, straw, and bagasse. Thus, the scientific interests of the industry start with the forests, and their future. Chronologically, or process-wise, the next major considerations are those of pulpwood deterioration during storage, and the utilization of bark and other wood wastes. From this point, the actual processing of the wood begins.

For chemical pulps, the wood is first mechanically chipped and fed to huge digesters where it is pulped by various processes in order to dissolve (to various degrees) the nonfibrous portions, leaving the cellulose fibers free for subsequent processing. The pulp is then drained and washed. It is at this point that the problem of liquor disposal, or utilization, first appears, and that chemical recovery processes are initiated.

On the other hand, mechanical pulp, or groundwood, is produced by grinding the barked log to the desired particle size.

Next, the fibers may be bleached, again by different methods and to different degrees. (Here, also, liquor disposal problems arise.) The fibers are now ready for the sequential operations arbitrarily classified under "papermaking."

The first step in papermaking is that of mechanically refining, or "beating," the fibers in order to induce the desired combinations and degrees of such properties as fibrillation, cutting, and surface gelation, or "hydration," for instance. Many basic properties of paper are largely determined by the refining operation. Next comes any of a host of "additives" that are used to impart specific properties to the fibers. These "additives" may be dyes, mordants, mineral fillers, sizing agents, gums, starches, and other polymeric materials. This "furnish" is then thoroughly dispersed in hundreds of times its own weight of water, pumped to the paper machine, and made into a continuous wet web of paper. Mechanically, and by evaporation, the water is removed to yield dry paper.

During the drying operation, or during subsequent separate operations, the paper may be given many other treatments to produce specific properties. Such treatments, however, are largely achieved through either coating or impregnating processes.

This, then, is the final paper which is ready to be converted into the gamut of products that so enrich our daily lives, and are so often taken for granted.

FIBROUS RAW MATERIALS

The pulp and paper industry is vitally interested in all knowledge relating to continued supply and optimum utilization of its major raw material—wood, both as it grows in the forest and as it is handled after cutting. The principal areas where additional information is needed are as follows:

Forestry

Silviculture

1. A study of pulpwood growth variables.
2. Fundamental information on forest classification (tree and stand) to serve as a guide to optimum harvesting practices for ensuring the growth and resistance of residual trees.
3. Methods of reforestation.

Ecology

1. Pathology: Investigations of insects and microorganisms which kill, or affect, living or down timber. Methods of control of deleterious insects and microorganisms.
2. Studies of the effects of forest conditions on insect and disease infestation.
3. Studies of the effects of silvicultural practices on insect and disease infestation.

Genetics

1. Selection and breeding of strains or hybrids possessing resistance to insects and diseases, exhibits fast growth, and gives high pulp yield.

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Wood Storage

1. Effect of time of storage of pulpwood on pulp yield and quality.
2. Investigations of insects and microorganisms that attack stored wood.
3. The effects of woodyard conditions upon insect and disease infestation.
4. Methods of controlling insects and diseases.

UTILIZATION OF WASTE

Wood

The fullest utilization of wood waste could easily make the wood-using industry the source of an enormous production of organic chemicals based upon lignin and the polysaccharides and their conversion products.

Wood waste available includes the tops and branches of trees apparently wasted in their entirety, the bark, the stumps, roots, partially rotted wood, sawdust, and the like. Glesinger in his book "The Coming Age of Wood" says: "One-half of the tree is wasted. The amount runs into many millions of tons annually in the United States."

Any chemical waste utilization process must be able to carry its load in open competition with the chemical industry. Given even a low return use for large amounts, wood waste would soon be producing alcohol and its various derivatives, together with yeast and many other materials.

Wet sawdust is one of the most difficult wood wastes to convert into useful products.

Bark

A large amount of pulpwood is delivered to the mill with its bark on. This is removed by either wet or dry barking methods. Thus, the bark recovered may be either wet or fairly dry. The dry bark is burned with the consequent production of B.t.u.'s; the wet bark is burned with difficulty.

Such bark is available in large amounts for conversion to technically useful products, The wood species include spruce, balsam, larch, jack pine, southern pine, western hemlock, Douglas-fir, birch, poplar, cottonwood, the oaks, the gums, and other lesser used species. The bark components will differ both in nature and in relative amounts as between species, and research must be carried out on the specific varieties.

In only a few cases have these barks been thoroughly studied either from a fundamental standpoint or from the standpoint of technical application. The exception includes Douglas-fir, western hemlock, and spruce. Much research has also been carried out with the bark of the redwood tree.

Those interested in bark research should consult the published work of the Weyerhaeuser Timber Co., The Institute of Paper Chemistry, McGill University, and Oregon State College.

The field of research in bark is relatively wide open.

Lignin

Lignin makes up from 20 to 30% of the wood substance going into the pulping process. It remains in the pulp in groundwood or mechanical pulp but is removed to a greater or lesser degree by all other pulping processes. Highly bleached pulps are almost completely delignified.

In the case of the sulphate and soda processes, the lignin removed by pulping is converted to B.t.u.'s; the lignin from the sulphite and neutral sulphite processes is sewered. The amount of lignin available for chemical conversion as a by-product of the pulp industry may run between 4 and 5 million tons per year and the amount from the lumber industry to many times that.

In spite of a vast amount of fundamental research, we are still ignorant of the chemical structure of lignin, nor are we in a much more favorable position with regard to salable chemical derivatives which may be produced from lignin to meet the competition of the organic chemical industry. It would also seem probable that many industrial applications for crude lignin remain to be discovered.

A new book, "The Chemistry of Lignin," by F. E. Brauns will be ready for distribution by Academic Press early this fall. This will give almost complete coverage on the scientific work already carried out with lignin and should be required reading for anyone starting in the field of lignin research.

PULPING PROCESSES

Of the widely used chemical pulping processes, the acid sulphite process is the oldest. This process employs a solution of calcium bisulphite containing free sulphur dioxide to dissolve the nonfibrous portions of the wood. Next oldest is the soda process which employs a sodium hydroxide solution, but its importance today is overshadowed by another alkaline process, the kraft process, which employs a mixture of sodium hydroxide and sodium sulphide. Relatively new, and rapidly expanding, is the neutral sodium process which employs a solution of sodium sulphite in combination with sodium carbonate, bicarbonate, or hydroxide. (See Recovery Problems for more detailed statements of pulping processes.)

There is considerable information in the literature on the mechanism and kinetics of the reactions of well-known pulping processes. The classical researches of Maas, Hägglund, and many others have been, and continue to be, informative and useful contributions. The effects of changes in most of the pulping variables on pulp yields, and the usually measured physical and chemical pulp characteristics, are fairly well known. There remains, however, much to be learned, particularly for the newer processes and for variations in the older processes. Perhaps some of the most potentially useful areas for further work in this field include:

1. Development of methods for measuring the morphological and structural changes, as well as the chemical changes, which occur when wood is pulped. The lack of techniques and tools in this field is probably a major factor in the slow progress toward understanding the mechanism and kinetics of wood pulping reactions. This, in turn, limits the understanding of the variables contributing to pulp qualities and characteristics.

2. In acid pulping the effects of the several pulping variables on reaction mechanism and kinetics need to be established for bases other than calcium, such as magnesium, ammonia, and sodium.

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3. In kraft pulping, additional work on the mechanism and kinetics of the reactions is needed, particularly for high-yield pulping.

4. Largely unexplored is the subject of the mechanism and kinetics of reaction in neutral sodium sulphite semichemical pulping.

5. Similarly, the mechanism and kinetics of aqueous and mineral acid prehydrolysis treatment of chips have not been comprehensively investigated.

6. The field of multiple-step cooking is almost completely open for investigation.

Studies such as those listed above will serve as a foundation on which to base the development of optimum methods for delignifying wood.

RECOVERY PROCESSES

Kraft Recovery

In the kraft recovery process the spent liquor is concentrated and turned under a reducing atmosphere to form a smelt of sodium carbonate and sodium sulphide with small quantities of several other sodium compounds. The flue gases from the combustion furnace consist mainly of carbon dioxide, carbon monoxide, water vapor, oxygen, and nitrogen. There are also present small amounts of odorous compounds such as sulphur dioxide, hydrogen sulphide, methyl mercaptan and dimethyl sulphide, and suspended solid particles consisting mainly of sodium sulphate. These compounds when discharged to the atmosphere constitute a nuisance to the surroundings, as well as losses of the active chemicals, sulphur and sodium. The kraft smelt is dissolved in water to form an aqueous solution of sodium carbonate and sodium sulphide which is commonly referred to as "green liquor" to distinguish it from "black liquor" (which is the waste liquor from the digester prior to the combustion) and "white liquor" (which is the cooking liquor after the causticization of the green liquor). In the smelt-dissolving operation, hazardous explosions sometimes occur, the causes for which are not exactly known.

In spite of the high efficiency attained in a modern kraft system for the recovery of sodium, there is much to be desired in regard to the sulphur recovery. The greater loss of sulphur relative to sodium in the recovery cycle lowers the sulphidity of the white liquor and thereby imparts adverse effects in cooking. As a basic approach to this problem, a study of the distribution of sodium and sulphur, especially in the combustion stage, would be very desirable. A better understanding of the thermodynamic behaviors of the various sodium-sulphur compounds and the kinetics of the reactions involved would undoubtedly enlarge the present knowledge concerning combustion of kraft black liquor.

One of the possible causes leading to explosions in the smelt dissolving tank is thought to be the formation of metallic sodium under the conditions in the combustion furnace. The violent reaction of sodium with water would then result in explosions. The validity of such a hypothesis may be examined from a thermodynamic viewpoint in conjunction with an experimental investigation, if pertinent data are available.

The stack losses of active chemicals may result from both mechanical entrainment of fine solid particles and vaporization of sodium compounds. Once the actual mechanisms of the material transfer are elucidated, some effective means may be devised to reduce the losses. Likewise, the exact causes of the stack odors must be determined before methods of prevention and cure can be appropriately examined.

Acid Sulphite and Neutral Sulphite Pulping Processes

In the pulping of wood by the calcium-base sulphite process, a solution of calcium bisulphite containing free sulphur dioxide is used. The spent liquor from the digester contains calcium lignosulphonate, sugars, and sugar-bisulphite compounds, dissolved sulphur dioxide, inorganic calcium salts, and small amounts of miscellaneous sulphur compounds of organic nature. The waste liquor is discarded to the sewer as a general practice because of the lack of suitable means for utilization or recovery. This has created serious stream pollution problems through the depletion of oxygen resulting primarily from the sugars contained in the waste liquor.

A number of attempts have been made for the recovery of heat and chemicals from the spent sulphite liquor as in the kraft process but none of them has yet met with complete success. Several difficulties are involved in the recovery of a calcium-base liquor. Upon evaporation, the liquor deposits scale-forming calcium salts. Considerable progress has been made in this evaporation problem. The combustion of a concentrated liquor results in a large quantity of fly ash which is difficult to collect and handle. Finally, the solids resulting from the combustion are mostly calcium sulphate and sulphide which are not readily converted to the forms suitable for making the cooking liquor.

In evaporating and burning a sodium-base acid sulphite liquor, it appears that the scaling and fly ash difficulties should be no worse than in the conventional kraft process. If the combustion is conducted with a reducing zone in the bottom of the furnace, a smelt of sodium sulphide and sodium carbonate is obtained. Although sodium carbonate can be readily converted to sodium sulphite and bisulphite by treatment of the smelt solution with sulphur dioxide, sodium sulphide under the same treatment tends to form both sodium sulphite and sodium thiosulphate. Alternatively, the smelt solution may first be treated with carbon dioxide to convert sodium sulphide to sodium carbonate and hydrogen sulphide, but the complete process is rather involved. The dissolved smelt may be subjected, in a somewhat expensive operation, to cation exchange in which hydrogen sulphide and carbon dioxide are evolved. The sodium retained by the exchanger may then be recovered to make the cooking acid, using a solution of sulphur dioxide from the combustion of hydrogen sulphide. It is said that sodium sulphide may be oxidized, with some difficulty, to sodium sulphite in a moist semi-solid state.

The burning of a magnesium-base liquor results in magnesium oxide and sulphur dioxide, which can be readily reused. The recovery process for magnesium base has been more highly developed than for any base, other than calcium, by virtue of one existing commercial operation.

The recovery of ammonia from an ammonia-base liquor requires a different approach because of the instability of the ammonium salts at elevated temperatures. It has been suggested that the spent liquor be

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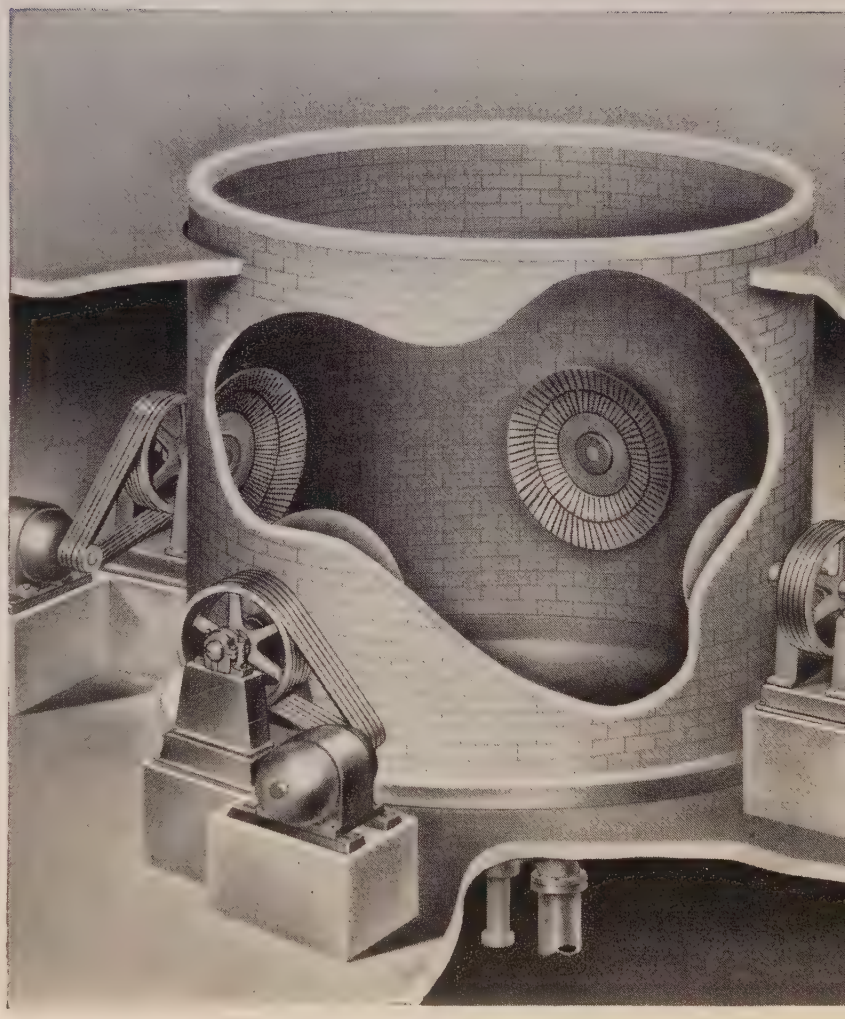

The stock is charged all at one time to the top of the vat. Four DynoPellers (described below) subject it to the vigorous dynomizing action that completely separates each fibre from its neighbor, maintaining its original length. The simple operating principle and design of the QuatroPulper eliminates the "wracking" and grief of other types of pulpers. Because there are few moving parts there is no loss of production time due to repair or adjustment. The QuatroPulper defibers the stock at low cost and produces a high quality slurry quickly and effectively.

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converted to a solid mass and then subjected to a pyrolysis for the liberation of ammonia and sulphur dioxide.

In the neutral sulphite pulping process, a solution of sodium sulphite in combination with sodium carbonate, bicarbonate, or hydroxide is used. The recovery of heat by combustion can be conducted in a manner similar to the kraft process and offers no particular difficulty. The conversion of sodium sulphide in the smelt to sodium sulphite, as in the case of the sodium-base acid sulphite liquor, constitutes a major recovery problem. At present, the only practical method of recovery for the neutral sulphite liquor is to use it, to a certain limit, as chemical make-up for kraft production when the two processes are in a joint operation.

From the above brief review of the status of some of the recovery problems in connection with the sulphite and neutral sulphite pulping processes, it is obvious that much remains to be done in the development of satisfactory recovery methods. A basic study of the chemistry of sulphur, such as the thermodynamic behaviors of the various sulphur compounds, especially at high temperatures, the solubility relationships of these compounds, the mechanism and kinetics of the reactions involved in the conversions, the distribution of sulphur in the different phases under combustion conditions, will contribute much to the solution of some of the difficulties mentioned above and may indicate new approaches to the problem of chemical recovery. Fundamental investigations are also required concerning the nature of corrosion of the acid and neutral spent sulphite liquors, the nature of calcium scales, the mechanical and electrostatic behaviors of fly ash, the absorption, with chemical reactions, of sulphur dioxide and ammonia from the flue gases, etc., to elucidate some of the engineering aspects of the recovery problem.

PULP WASHING

Common to all pulping processes, washing is a necessary and important operation for the separation of soluble ingredients from the fibrous materials. The removal of dissolved residues in the liquor, either by displacement or by dilution, must attain as high a separation as practicable. In the kraft and soda processes, furthermore, and probably soon in the sulphite and semichemical process, the losses of the soluble materials and the dilution of the black liquor must be kept at a minimum to achieve a high recovery of chemicals and heat.

Two types of washing equipment are in general use—diffusers and rotary-drum vacuum filters. The diffuser system is gradually being replaced by the more modern multistage countercurrent vacuum washer system. The problem of foaming in a vacuum washer is a serious one in many cases. A study of surface tension and other related physical properties of black liquor in contact with air at a relatively high temperature (150 to 180°F.) and vacuum would be helpful in overcoming the foaming difficulty and further improving the operating efficiency.

In spite of the rapid advance in the art of pulp washing, there remains much room for improvement through a basic understanding of diffusion and filtration. The mechanism of water removal from a compressible porous pad is basic to the filtration of pulp. The development of a quantitative relationship between the rate of flow and the other system variables would serve as a sound basis for the correlation of the present meager empirical knowledge on the subject. Such a fundamental study of the drainage characteristics of pulp would also aid in an accurate evaluation of the relative efficiencies and merits of the diversified washing systems in use.

BLEACHING

Following the chemical pulping operations further purification is often carried out by bleaching. Whereas bleaching may not be desirable for some grades of pulp, it is often the best means of improving chemical purity or of enhancing the brightness (or whiteness) of pulps when these properties are desired.

The bleaching of wood pulps has been carried out predominantly with chlorine or chlorine compounds. So-called chlorination bleaching may be done either with chlorine gas or with a water solution of chlorine, under strongly acid conditions. Oxidizing bleaches may employ the hypochlorite of sodium or calcium, under alkaline conditions. (See Corrosion Problems and Bleaching, for a more detailed statement of present bleaching practice.)

Interest in the use of chlorine compounds for bleaching is high. There is in addition, interest in other compounds, either of a reducing nature such as sulphur dioxide or zinc hydrosulphite, or of an oxidizing nature such as the peroxides or chlorine dioxide.

As in pulping studies, a more adequate understanding of the mechanism and kinetics of bleaching reactions is needed. Particularly is this true with the newer oxidizing agents, such as chlorine dioxide and the peroxygens, and the reducing agent, zinc hydrosulphite. In this field, considerable data are available on the effects of changes in the usual bleaching variables. However, a fuller understanding must await more basic knowledge of the behavior of the systems involved.

WATER CONSERVATION

Because water is vital to the pulp and paper industry, that industry must devote an increasing amount of its attention to the conservation and better utilization of water. In general the activities of this industry fall into three categories:

Watershed Management

To the pulp and paper industry stream improvement is just as important above the mill as below. Much effort has been put forth in the past to combine watershed management with reforestation, and thus insure the industry at once with an ample supply of water and wood. But good watershed management involves more than simple reforestation. Many areas in a watershed may not be suitable for growing forests, and in many cases these areas have been abandoned to wind and soil erosion. Good watershed management has three essential features:

1. Reforesting areas and/or good forest management of those areas suitable.
2. Cooperating with and educating farmers in the tillage practices which are designed to minimize loss of soil from cultivated areas.

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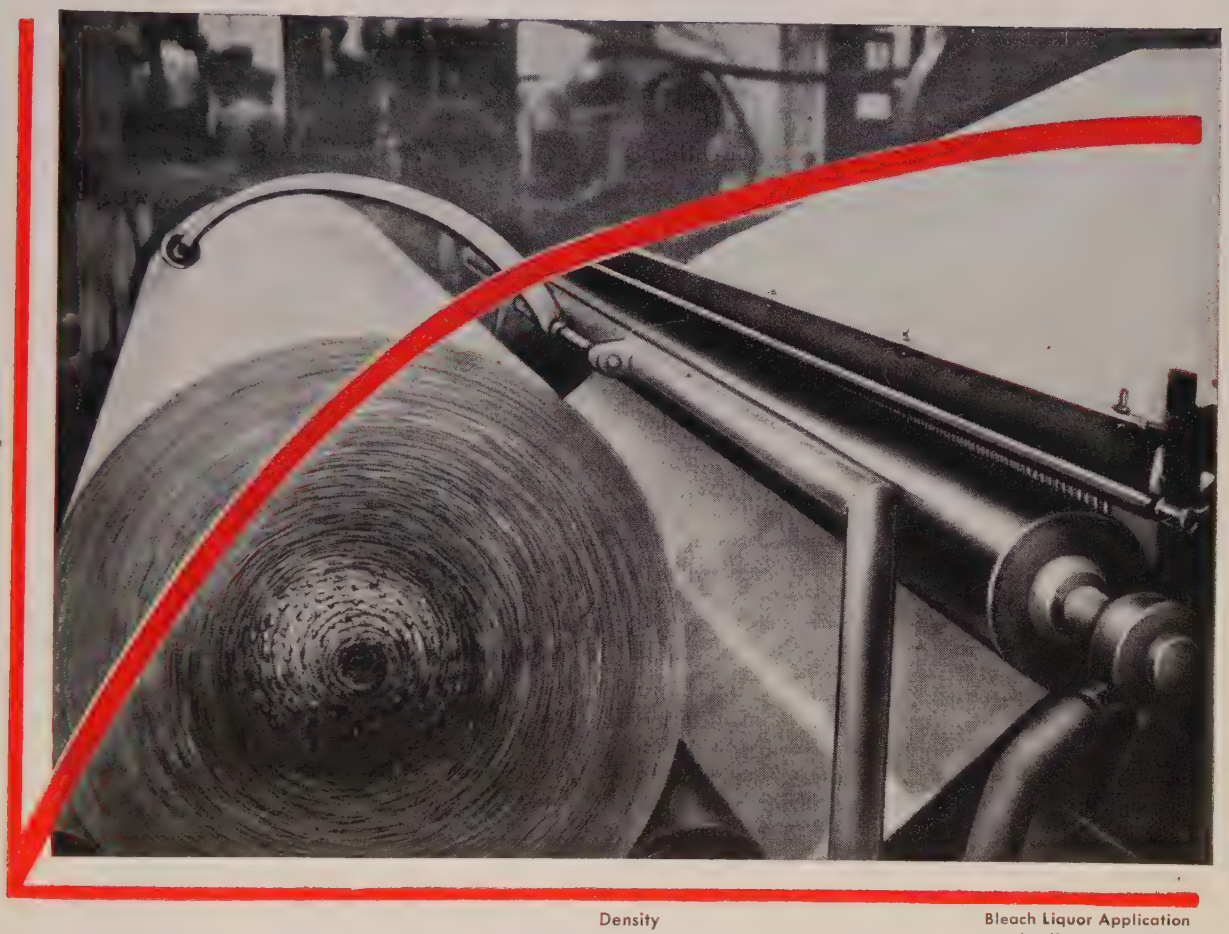

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3. Providing some sort of cover, such as grass or other vegetation, for those areas not suitable for farming or forest.

(The ultimate object is to provide a "sponge" of vegetation in a watershed, so that it will hold the rainfall for more gradual runoff. Thus, the streams will have a more constant flow and the character of the water will be much improved both from the standpoint of industry and of the people.)

Problems

1. Watershed inventory of (a) areas suitable for farming, (b) areas suitable for forestry, (c) areas suitable for grass or similar cover only, (d) soil types and soil improvement, and (e) types of cover best suited to abandoned or waste areas subject to erosion.

2. Initiation of remedial programs.

Water Utilization in Mills

Because water has been so plentiful in the past, the pulp and paper industry has tended to be profligate in its use. In recent years much progress has been made in individual mills in the art of better water utilization, but much more must be done. With the development of improved filters and other devices for water treatment, the reuse of waters formerly discarded is becoming more and more common.

Problems

1. Evaluation of present and future devices for filtering various types of mill water from the standpoint of their technical and economic feasibility.

2. Research on and development of new devices designed to treat water now being used in a way that it can be reused.

Stream Improvement Below Mill (Pollution Abatement)

The manufacture of pulp and paper requires large amounts of process water. During the time this process water is being used, solids, in one form or another, are added to it; these solids are the fundamental cause of the disposal problem. If the waste waters, containing these solids, are sent to the stream, as is the case in most pulp and paper mills, they may (1) lower the oxygen concentration of the stream to a point detrimental, if not fatal, to aquatic life, (2) destroy aquatic life by their toxic action, if such exists, and/or (3) their suspended solids may settle on the stream bed, resulting in a situation inimical to aquatic life. It is apparent, therefore, that, fundamentally the pollution abatement problem of the pulp and paper industry is predominantly one of solids removal from its waste waters. The most serious pollution abatement problems in the pulp and paper industry arise from the chemical pulping of wood and from bleach plants.

1. Sulphite Pulping (Spent Sulphite Liquor). The present trend is to evaporate and burn this liquor.

Problems

(a) The evaporation and burning of calcium-base liquor. Currently, the basic problems of this process are fairly well understood.

(b) Substitution of a base other than calcium (ammonium, magnesium, or perhaps others), followed by evaporation and burning. Problems in heat and chemical recovery.

(c) Fundamental investigation of the utilization of the noncellulosic constitutents of wood found in the waste liquor (see Utilization of Wastes, Lignin).

2. Kraft Pulping.

Problems

(a) The removal of solids from kraft wastes (these solids are present in relatively low concentration) to the point that the water can be reused, or, at best, will have little effect on the receiving water.

(b) Air pollution abatement.

3. Semichemical Pulping.

Problems

(a) The treatment of the spent cooking liquor to recover chemicals and heat.

(b) The possibility of these spent liquors being toxic.

(c) Other means of disposal.

4. Deinking Waste.

Problem

(a) Removal of inert solids, as well as of B.O.D.

5. Bleach Plant Waste Waters.

Problems

(a) Treatments designed to remove both B.O.D. and/or solids.

(b) Color removal from wastes in some cases.

6. Paper Mill Wastes.

Problem

(a) Suspended and other solids removal.

DEINKING RECLAIMED PAPER

The fibers in reclaimed paper are currently recovered by deinking processes for reuse as a part of the fiber stock for the manufacture of some grades of paper. In addition to the ink pigments on the surface of the printed paper, one or more other pigments (e.g., clay, calcium carbonate, satin white, and calcium sulphate) are often present either as a coating on the surface of the paper or as a filler distributed throughout the sheet, or both. In current deinking practice, the wastepaper is disintegrated and cooked with alkali, dispersing agents, and various other materials with the purpose of dispersing the printing ink pigment, so that it can be removed from the stock by washing. The brightness of the washed stock is subsequently improved by bleaching.

In thus cooking and washing the stock, the filler and coating pigments are also dispersed and separated from the fibers together with the fine fibers and fiber fragments not retained by the fiber mat on the washers. The effluent from the washers contains the dispersed ink and the filler and coating pigments and fiber fines. The dispersed ink usually constitutes only a small fraction of the total solids suspended in the waste. The filler and coating pigments and fiber fines add greatly to the stream pollution problem if the untreated waste is dumped into a stream or lake and are difficult to remove from the effluent in efficient and economical fashion.

Additional investigations along two lines are needed:

1. Investigation of deinking processes or deinking waste treatments which may lead to more efficient and economical methods of separating and handling the solids in deinking wastes.

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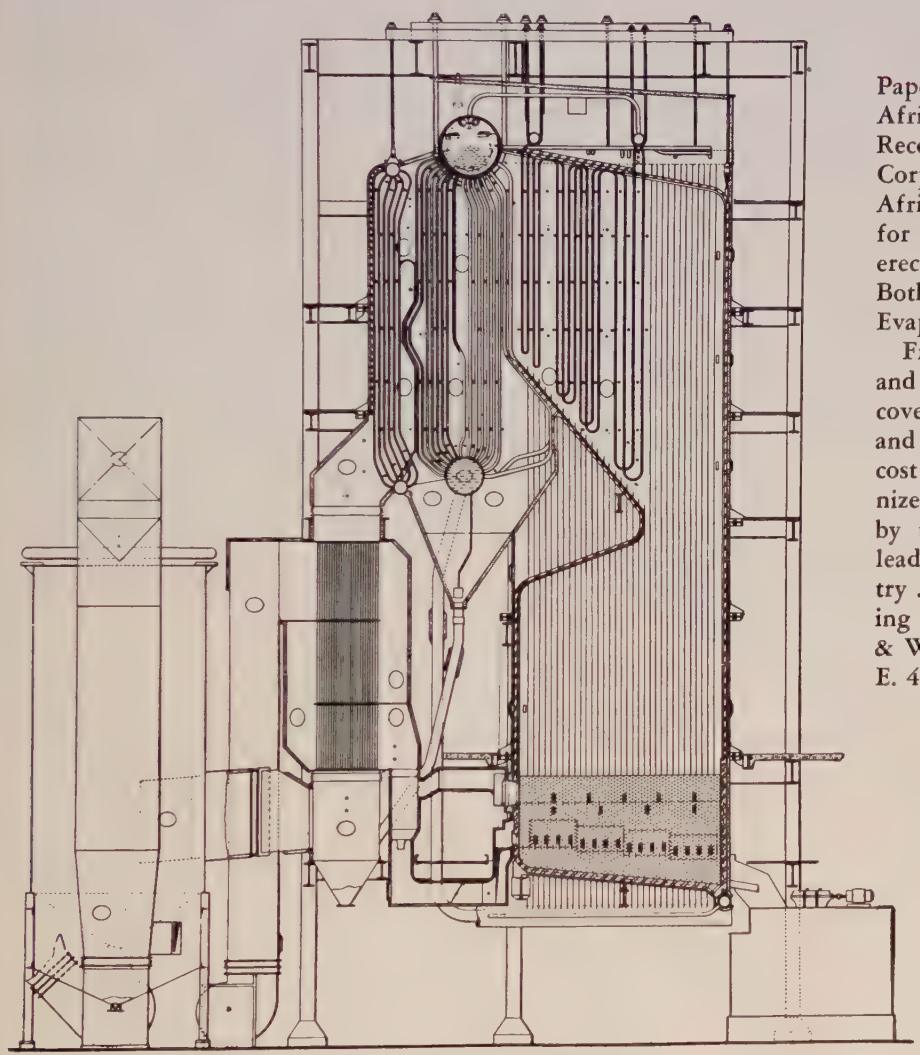
# of B&W Recovery Units REPUTATION GOES A LONG WAY ...to South Africa



200-Ton B&W Recovery Unit with B&W Cyclone Evaporator for Outdoor Installation in Zululand.

Paper Industries, Ltd. of Springs, South Africa, have been operating a 75-ton B&W Recovery Unit for several years. Union Corporation, Ltd. of Zululand, South Africa, have ordered a 200-ton B&W Unit for outdoor installation; it is now being erected. This represents a repeat order. Both units will have B&W Cyclone Evaporators.

From Oregon to Florida, to Zululand and Finland, the reputation of B&W Recovery Units for highly efficient chemical and heat recovery, reliability, and low-cost operation and maintenance, is recognized. It is a reputation firmly established by the performance of B&W Units in leading mills throughout the paper industry . . . a reputation that is rapidly reaching world-wide proportions. The Babcock & Wilcox Company, Boiler Division, 161 E. 42nd Street, New York 17, N. Y.

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2. Investigation directed toward the development of a deinking process in which the ink is selectively attacked and separated from the other components of the paper, thus reducing the loss of other pigments and fiber fines which are reusable and which, if not recovered, add to the waste disposal problem.

RETENTION OF BEATER ADDITIVES

Comparatively few papers are made from cellulose fibers alone. Most papers contain one or more nonfibrous materials such as dyes, mineral pigments, adhesives, sizing agents, deflocculants, synthetic resins, etc., in order to impart to the final paper some property which could otherwise be deficient or absent. Under the conditions used in papermaking, all these classes of materials normally assume the colloidal state and depend upon some form of surface energy for their mechanism of action in a papermaking system. However, with the exception of dyes, comparatively little study has been made of the surface properties of these materials in relation to the papermaking system and, even in the case of dyes, considerably more research needs to be done particularly with regard to the rate of dyeing. Let us consider these materials in greater detail under the following headings:

Fillers and Loading Materials

Fillers or loading materials are used in papers to improve the opacity, brightness, and printability, and as a substitute for the more expensive cellulose fiber. Large tonnages of papers are made containing fillers; this is evident from the fact that the annual consumption by the paper industry of kaolin clay alone is approximately 350,000 tons. In addition to this amount of clay, large tonnages of calcium carbonate, zinc sulphide, barium sulphate, gypsum, titanium dioxide, and others are used. In general, the amount of filler added to the paper varies between 5 and 20%. However, many book papers may contain as high as 25 to 40% of calcium carbonate. It is desirable that the particles in a good filler have a high refractive index and vary in size between 0.1 to 2.0 mu in diameter and be as uniformly small as possible. Such materials possess large specific surfaces and usually exhibit strong adsorptive powers.

The importance of the surface properties of clays and carbon blacks has been recognized for many years in the rubber industry. The addition of properly prepared pigments to rubber greatly improves the strength properties, such as tensile strength and abrasion resistance. However, in marked contrast to the effect of filler materials in rubber, the incorporation of such fillers in paper markedly lowers the strength properties and this decrease in strength definitely limits the amount of filler which can be added to paper. Moreover, the retention of fillers in paper depends primarily upon a filtration mechanism. Consequently, retention is poor and it is necessary to carry a much larger quantity of filler in the papermaking stock than is retained in the sheet. The filtration mechanism of retention of the filler is largely responsible for the two-sidedness of paper —that is, the presence of more filler on one side of a sheet than on the other. These problems of poor retention, two-sidedness, and lowered strength properties have plagued papermakers for many years, and are problems which should receive attention from a fundamental standpoint. One possible solution to these problems lies in the utilization of the adsorptive forces of fillers in such a way that (1) the filler particles coagulate upon and become fixed to the surface of the fibers in a uniform manner, and (2) the fillers participate in the bonding of the sheet.

Beater Adhesives

The strength properties of the finished sheet are very important considerations in the manufacture of most papers. In order to obtain the required strength properties, it is necessary to beat and refine the pulp in one or more engines which accomplish a pounding, scraping, cutting, and rubbing action on the cellulose fibers. The outstanding property of beaten cellulose fibers is their ability to bond together when they are dried in contact with one another. The beating and refining operations are not only very costly, but are quite destructive to the natural fiber structure. Papers which are made from progressively more highly beaten pulps have greater strength up to a certain point, but they also possess certain detrimental properties with regard to certain use requirements. As the strength properties of a sheet increase, in general the opacity, compressibility, and oil ink receptivity decrease, and the hygroexpansivity increases. Also, the sheet becomes much more dense and less porous. For printing purposes, these trends in properties are undesirable. In an attempt to overcome the undesirable properties produced by mechanical beating, the papermaker often adds short fiber filler pulps which increase the printing properties but greatly decrease the sheet strength. Furthermore, it is becoming increasingly necessary to use larger proportions of these short-fibered, low-strength pulps because the long-fibered conifer pulps are becoming more difficult to obtain. Thus it is becoming progressively more difficult to manufacture papers of adequate strength.

Papermakers have long sought a means of causing cellulose fibers to bond strongly together with little or no beating. One method of doing this is to add a material which will cement the fibers together in the final sheet. Numerous adhesive materials have been suggested and tried for this purpose and certain of these materials have met with considerable success. Among these may be mentioned starch, various gums (such as locust bean gum and guar gum), carboxymethylcellulose, methylcellulose, and certain synthetic resins—notably those made from ureaformaldehyde and melamineformaldehyde. Certain of these materials appear to be adsorbed from dilute aqueous solutions by cellulose fibers. Others must be flocculated or precipitated from solution by the addition of flocculating agents. All such materials improve the strength properties of papermaking pulps significantly, but to considerably different extents. Those materials which must be flocculated upon the fibers tend to make a two-sided sheet of paper, wherein more of the flocculated additive is retained on one side of the sheet than on the other. Those materials, which appear to be physically adsorbed by cellulose fibers, give a uniform film of the sorbed material on the surface of the fiber and provide much better bonding between the cellulose fibers in the finished sheet. In most cases, such adsorbed materials also have the ability to delay flocculation of cellulose fibers, and thereby improve the fiber distribution, or formation, of

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the sheet of paper. This provides more uniform strength and surface properties of the sheet, and is very desirable. The sorption of such materials has been studied only to a limited extent, and it has often been found that materials which work well in the laboratory give mediocre to poor results in mill applications. It is suggested that more fundamental study in this field would lead to results of great benefit to the paper industry.

Sizing Agents

Many types of papers and board are sized in order to reduce the rate of penetration of aqueous fluids with which the paper may come in contact. Two principal methods of accomplishing sizing of paper are: (1) the addition of substances, such as rosin and waxes, to the papermaking furnish in order to increase the contact angle between water and the surface of the final paper and (2) by plugging the pores of the sheet through applications of various adhesive solutions to the surface of the sheet. The first of these two methods presents the more important problems from a research standpoint and the following remarks pertain to the use of rosin and waxes for sizing. The principal problems connected with the sizing of papers and boards are: (1) summer or so-called warm weather sizing troubles wherein the degree of sizing falls off seriously when the temperature of the stock rises, (2) difficulty of consistently sizing high-grade "purified" pulps, (3) two-sidedness, wherein the sheet is better sized on one side than on the other, and (4) fugitive sizing, wherein the sheet may be highly sized when it comes off the machine but in which the sizing gradually disappears during storage.

Further studies are needed in this field with regard to: (1) the mechanism of retention of rosin and wax sizes and methods of obtaining better and more uniform sorption of the sizing agent, (2) the effect of particle size and particle-size distribution of sizing agents upon their sizing action and the effects of heat and machine conditions upon the size, (3) better methods of sizing "purified" pulps such as rag, alpha, and certain highly bleached pulps, and (4) development of new sizing agents which will give greater sizing efficiency.

CORROSION PROBLEMS

Some of the more important corrosion problems encountered in the pulp and paper industry may be conveniently divided into four categories of papermaking operations—namely sulphite pulping, alkaline pulping, bleaching, and sizing.

Sulphite Pulping

In the sulphite pulping process wood chips are subjected to digestion by a sulphur dioxide-bisulphite solution at elevated temperature and pressure. The cooking liquor may contain from 6 to 10% total sulphur dioxide, of which 1 to 2% are combined as the sulphite of calcium, magnesium, sodium, or ammonia; it may be subject in the digesters to temperatures up to 280°F. and pressures up to 90 p.s.i. During the acid preparation cycle, lower values of concentration, temperature, and pressure exist. It is these strongly acid solutions which give rise to the most serious corrosion problems in the sulphite industry. Also associated with cooking acid preparation is the combustion of sulphur and the cooling of the hot burner gas thus formed. The introduction of molten sulphur to the burners and the handling of the hot gas, which may be at a temperature as high as 2300°F., give rise to corrosion problems.

Alkaline Pulping

The alkaline pulping processes depend upon the action of alkaline solutions for the delignification of wood. In the soda process, the cooking liquor is a solution of sodium hydroxide, usually containing some sodium carbonate. A more widely used alkaline cook is the kraft, or sulphate, process in which the cooking chemical is a mixture of sodium hydroxide and sodium sulphide with some sodium carbonate and sodium sulphate usually present. Kraft cooking liquors may contain from 10 to 12% total alkali with a percentage of total alkali present as sulphide of from 15 to 30%. The digester pressure may be as high as 130 p.s.i. with a temperature up to 350°F. After digestion, the spent liquor (black liquor) containing large quantities of dissolved organic matter, is separated from the pulp by washing, concentrated to 55–60% total solids by multiple-effect evaporation, and burned. The sodium carbonate-sodium sulphide smelt from the furnace is dissolved in water to form "green liquor," which is then causticized with lime to regenerate the pulping solution (white liquor). Make-up chemical for the system is usually solid sodium sulphate, which is added to the concentrated black liquor immediately before the burning operation. Corrosion difficulties are experienced throughout the whole cooking and recovery cycle. The flue gases (water vapor, carbon dioxide, and some sulphur dioxide) from the recovery furnace are treated in scrubbers, precipitators, or the like to recover as much of the sodium sulphate dust as possible. This usually necessitates the cooling of the gases below the dew point; the liquid phase which forms is very acidic and corrosive.

Bleaching

Most of the bleaching of chemical wood pulps is conducted with chlorine and chlorine compounds. In a typical multistage bleaching operation, chlorine gas or a solution of chlorine in water is used in the first stage. This is followed by a caustic extraction stage using sodium hydroxide which, in turn, is followed by one or more oxidation stages with calcium or sodium hypochlorite. Chlorine dissolves in water with the formation of equimolal quantities of hypochlorous and hydrochloric acid and, thus, the medium in the first stage has a very low pH (usually less than 2) and a high chloride ion concentration. The hypochlorite solutions used in the later stages are well on the alkaline side (pH about 11 to 12) and also contain high chloride ion concentration. Corrosion problems are present throughout the entire bleaching operation. Two different processes have been evolved for the bleaching of groundwood (wood pulp prepared by mechanical grinding). The first process uses dilute sodium or hydrogen peroxide solutions in the presence of small amounts of sodium silicate and magnesium sulphate (as buffers and stabilizers). Corrosion problems in this operation are complicated by the fact that many common metals used in equipment construction bring about the catalytic decomposition of the peroxide bleaching solutions (pH about 9 to 11). In the other process, zinc hydrosulphite

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solutions are used in either a hot (up to 200°F.) or a cold (room temperature) bleaching process. Dilute solutions of this salt of hydrosulphurous acid are quite corrosive.

Sizing

One of the severest corrosion problems in the paper making operation arises in connection with sizing, which is carried out in the pulp refining equipment or later in the system. The most common sizing material is rosin, which is added as a mildly alkaline emulsion and offers no corrosion difficulty. However, it is necessary to precipitate the size with alum, which is added in an aqueous solution varying in concentration from 10 to 50%. These alum solutions are very acidic and difficult to handle. The pH of the furnish going to the paper machine ranges from about 4 to 6, and this acid condition gives rise to corrosion problems.

The above-mentioned difficulties, specific to the pulp and paper industry, often lead to conditions which are so severe that even the most corrosion-resistant materials are found wanting. For the most part, however, staterials reasonably satisfactory from the corrosion mandpoint are available, although in many instances mechanical shortcomings or high cost make the development of other materials extremely desirable. Any basic research that tends to minimize the effects of corrosion will be helpful to the pulp and paper industry.

DRYING OF PAPER

One of the important operations in the manufacture of paper is the drying operation in which the wet paper web with a moisture content of from 60 to 70% goes from the press section at the wet end of the paper machine through the drier section, from which it leaves at about 90 to 95% dry. The usual drier section consists of a series of internally steam-heated drums against which the sheet is ordinarily held by means of an endless canvas felt. In some cases, where the sheet has been dried in such a manner and then remoistened in a size tub or by the application of a coating color, it is redried by the passage of hot dry air over it as it is run through a heated chamber or loft.

In attempts to aid in the design of drying equipment to better the efficiency of the drying operation, and to improve the properties of the product, a considerable number of investigations of the drying of paper have been carried out. These works have resulted in the formulation of a number of concepts and hypotheses of the fundamental mechanism of paper drying and the basic laws by which it is governed, but no one mechanism will completely describe the operation; nor has any direct and completely conclusive experimental evidence been offered, as yet, in support of the various theories and relationships. It is generally accepted that the rate-of-drying curve for paper is similar, at least in part, to that obtained for many porous solids—i.e., the rate of drying is constant until a certain moisture content is reached, after which the rate decreases and approaches zero at zero moisture content. However, the exact mechanism of water removal during these rate-of-drying periods is still a matter of considerable conjecture.

Besides involving the cellulose-water relationship, a fundamental approach to the problem would deal with elucidation of some of the following questions:

1. What is the mechanism by which water leaves the sheet, and how is the removal of water affected by pulp and paper properties, such as smoothness, porosity, formation, thickness, amount of refining, and type of pulp?
2. What role, if any, do the following factors play in limiting the rate of drying at various degrees of water removal: heat transfer to and within the sheet, water-vapor removal from the surface, and diffusion of water or water vapor through the sheet?
3. What are the effects of drier felt characteristics, moisture content, and temperature?

PROPERTIES OF PULP AND PAPER

Basic investigations of the properties of pulp and of paper will be welcomed. Such information serves as a sound foundation for developing better means of evaluating pulp and paper, for controlling their manufacture and for developing new or improved paper products. The following specific subjects are illustrative:

The Papermaking Properties of Fibers

The properties of fibers which influence papermaking characteristics are several in number and, in many instances, they are not isolated in a fundamental way or measured reliably by techniques now available. The significant properties include those which may be classified as physical, physical-chemical, and chemical, as well as those which are purely dimensional (fiber length, etc.).

The fiber properties which are of significance in papermaking result in part from the source and history of the pulp—i.e., the original source and nature of the fibers and changes which may have taken place during pulping, bleaching, and other purification processes.

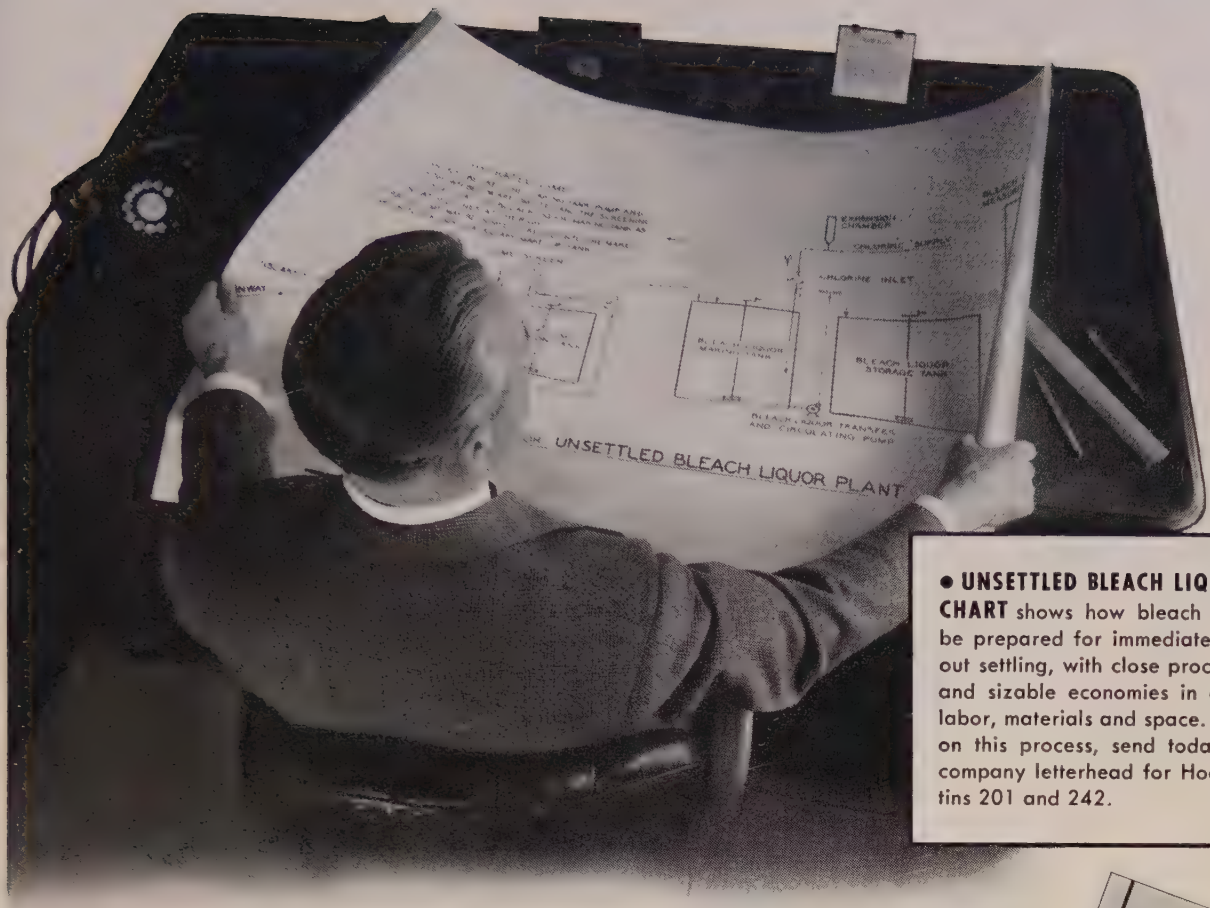
The composite of the fiber properties of a pulp may be considered to represent a starting point, and the change of individual properties during stock preparation and refining—i.e., the response of the fibers to processing—is of fundamental significance in an interpretation of papermaking properties.

The papermaking properties of fibers can presently be ascertained only by making paper sheets, the manner of formation of the sheets and the means of evaluation of the sheet properties are of basic importance in the interpretation of papermaking properties of fibers.

Studies of the papermaking properties of fibers represent a broad area of research. It may be expected that many studies of limited scope and of fundamental character will be necessary to provide an intelligent background, from which simultaneous attack by a variety of techniques may permit a better understanding of the problem in its wider aspects.

The Crystallinity of Cellulose

The crystallinity of cellulose is of significance in relation to the physical properties and chemical reactivity of the preparation. The crystallinity of cellulose is measured by a number of methods, which do not give identical results because the size and nature of crystalline and noncrystalline regions affect the results obtained upon application of the various methods. It is desirable to measure the crystallinity of cellulose preparations, since this property is related to physical properties and chemical behavior and reactivity. Also, it



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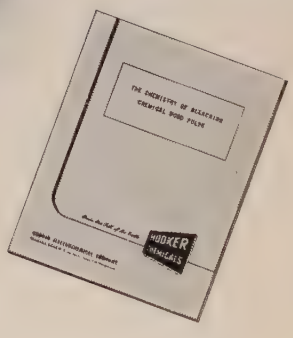

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would be of value to arrive at fundamental interpretations of crystallinity measurements, and to devise new methods or to improve present ones with the objective of developing procedures which are simpler and quicker than those now in use.

Stress-Strain Characteristics of Paper

Almost all converting operations are preformed on a continuous basis—that is to say, a continuous web of paper is fed from a roll into the equipment involved. A study of the tension and tensile strain induced in paper in such converting processes (including printing), and of the relations between these and the properties of the paper and the mechanical conditions imposed by the various equipments, would be of value. It is considered important that the research recognize the importance of time effects; for example, determinations of load-elongation should involve rate of strain of the same order as that imposed by the converting equipment.

Fading of Paper

Of traditional interest, and still unsolved, is the problem of understanding the mechanisms by which pulps and papers fade in brightness on exposure to light, to heat, to the combination of light and heat, and to acid and alkaline conditions.

Loss of Strength and Brightness upon Heating

In the high-speed printing of magazines, drastic methods of drying are used in order to permit high-speed operation without excessively large equipment. Various combinations of steam-heated drums, hot air blasts, and gas flames are used—steam drum temperatures varying up to 350°F., air temperatures up to 600 to 700°F., and flame temperatures up to 2000 to 2500°F. The time of exposure of the paper is very short, the maximum being possibly one second for the less drastic temperatures. Paper temperatures are stated by various sources to reach from 300 to 500°F.

Under these "abnormal" conditions appreciable loss in brightness and strength of the paper takes place, resulting in either a limitation in the operating speed or a loss in quality. An elucidation of the underlying mechanisms is needed.

Absorption of Radiant Energy

Infrared, or radiation, drying of paper is of increasing interest. A basic necessity to rationalization of the design of such equipment is the determination of the specific absorption and scattering coefficients (of the recently modified Kubelka-Munk theory) of the principal components of paper for visible and infrared light.

CONVERTING OPERATIONS

Literally hundreds of different converting operations are preformed upon the basic sheet of paper in order to transform it into the final gamut of consumer products. However, a large part of these operations is based fundamentally upon either coating or impregnating the paper. The following discussion is illustrative of the problem in this field:

Penetration of Liquids

The controlled penetration of various aqueous and nonaqueous liquids into paper surfaces is an essential factor in the proper performance of almost every paper product during conversion or use. The degree of penetration required varies widely with the individual application, ranging—in the case of water—from maximum absorbancy for towelling and saturating papers to maximum repellency in weatherproof packaging.

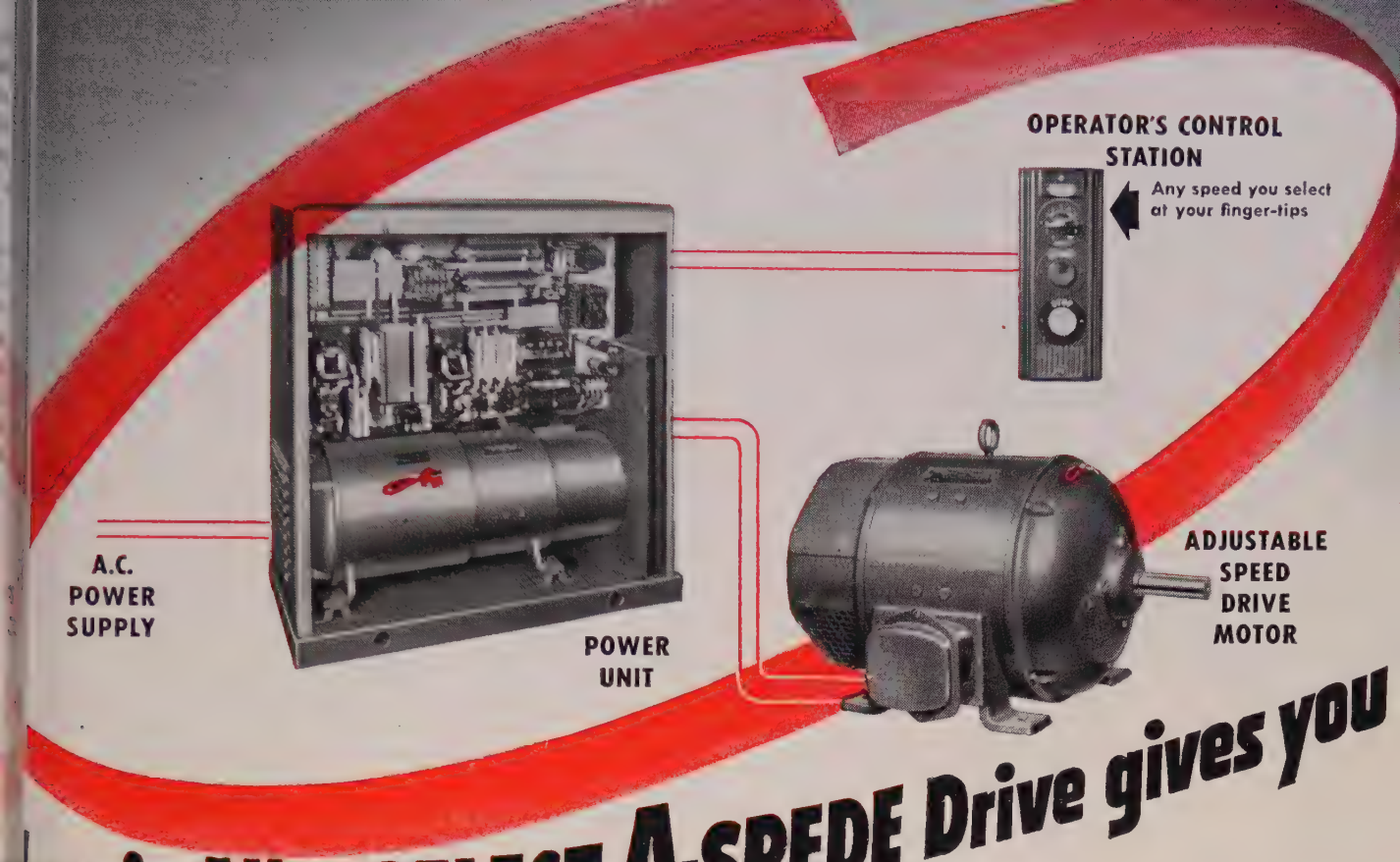
The broad theory of penetration of homogeneous liquids is fairly adequate, covering such factors as capillary size, surface tension, and contact angle. However, individual systems are much more complex and do not behave as homogeneous liquids. In the case of coatings, preferential absorption and filtering cause a separation of the pigment-adhesive-water system which must be properly controlled in order to effect good bonding. The separation of the components of printing inks has a great influence on their performance. In studying the resistance of food packages to passage of grease it is necessary to test with the particular product and conditions involved, because no generalizations or accelerated methods of testing have been found.

Thus, while present theory may suffice to explain and to predict the behavior of simple systems, it falls far short for more complex systems. An extension of fundamental knowledge of this field will be a welcome contribution.

Investigation of Rheological and Other Properties of Coating Mixtures

The coating of paper discussed herein will consider only the field of pigment coating in which aqueous mixtures of a pigment with an adhesive (such as casein or starch) are spread upon a sheet of paper.

The principal reasons for coating paper are to impart a much smoother surface to improve the printability of the paper, and to improve the appearance and color. Such coated paper is superior in many respects to supercalendered book paper for the production of fine halftone prints. The pigment coating of paper may be divided arbitrarily into two types. The first is the older or conventional style coating of paper which has been carried out for many years, and which involves the application of pigment-casein coating mixtures to the sheet at a relatively low solids concentration. Heavy coating weights are employed and very fine coated paper is made by this process. However, the process is relatively slow and expensive. There is a marked tendency in the coating industry today for an expansion of the second type of coating, termed machine coating, wherein the coating of the paper is carried out partway through the drier section of the paper machine. This latter type of coating is done at a much higher speed than conventional coating and, therefore it is necessary to use coating colors having a much higher solids concentration than those used in the older method. Machine-coating mixtures usually have a solids concentration in the range of 55 to 70% solids, whereas the older coating method rarely employs mixtures above 45% solids. The high machine speed and high viscosity used in machine coating preclude the use of brushes and other means for leveling or smoothing out the surface of the following coating application to the paper. Most machine coating is carried out by a roll coating process in which a film of viscous coating mixture is spread upon a coating roll and this film of coating is then applied to the sheet as



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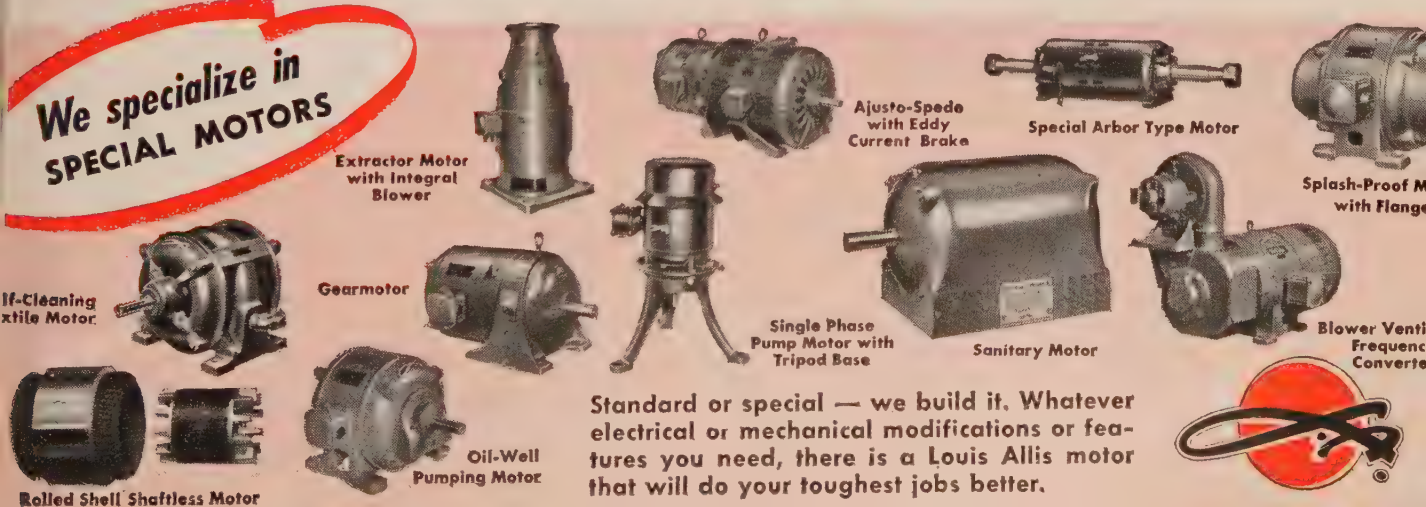

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it passes through the nip of the two rolls. The weight of coating applied to the paper in a machine coating process is approximately 3 to 8 pounds per side of paper. The machine speed and the high viscosity, which limits the solids concentration of the color, often determine the maximum weight of coating which can be applied to the sheet of paper. The machine speed varies between 800 and 1500 f.p.m., and thereby subjects the coating color to very high shearing stresses at the point of application of the coating mixture to the sheet. It is well known that high solids pigment-adhesive mixtures exhibit such rheological properties as dilatancy, thixotropy, and plasticity. The rheological properties of the coating mixture play a major role in the way in which the coating mixture spreads, penetrates, and anchors itself to the paper. The trend in coating is toward higher machine speeds and heavier weight coatings. This, of course, emphasizes the importance of the rheological properties of such higher solids coating mixtures applied at high rates of shear. For example, it is practically impossible to apply a coating mixture which exhibits dilatant characteristics to a sheet of paper at a high rate of speed because of the tremendous thickening effect as the stress in the nip is applied to the coating mixture. Such a coating mixture will result in a very rough coating under those conditions where it can be applied to the sheet, but this coating is unsatisfactory because of poor calendering characteristics and the resulting poor printing surface. On the other hand, thixotropic coating colors tend to become less viscous or more fluid when a stress is placed upon them and are, therefore, more desirable for machine-coating purposes. Many factors influence or can determine the rheological properties of the final coating mixture. Among these may be mentioned the mineral species, particle size, and particle-size distribution of the pigment used, the molecular weight, the degree of hydration, the type and concentration of adhesives used, and various additives such as fatty acids and soaps.

Coating Studies

Further studies along the following lines are needed in the field of coating:

1. The development of better methods for determining machine operability of coating mixtures at high rates of shear.

2. The determination of the factors which cause certain coating mixtures to develop a rough surface pattern on the sheet.

3. The influence of molecular weight and molecular weight distribution of aqueous adhesives such as converted starch and casein upon the properties of coating mixtures.

(a) Effect upon viscosity and other rheological properties.

(b) Effect on penetrability of the coating mixture into porous surfaces.

(c) Effect upon the leveling (roughness) of the coating.

(d) Effect on adhesive strength.

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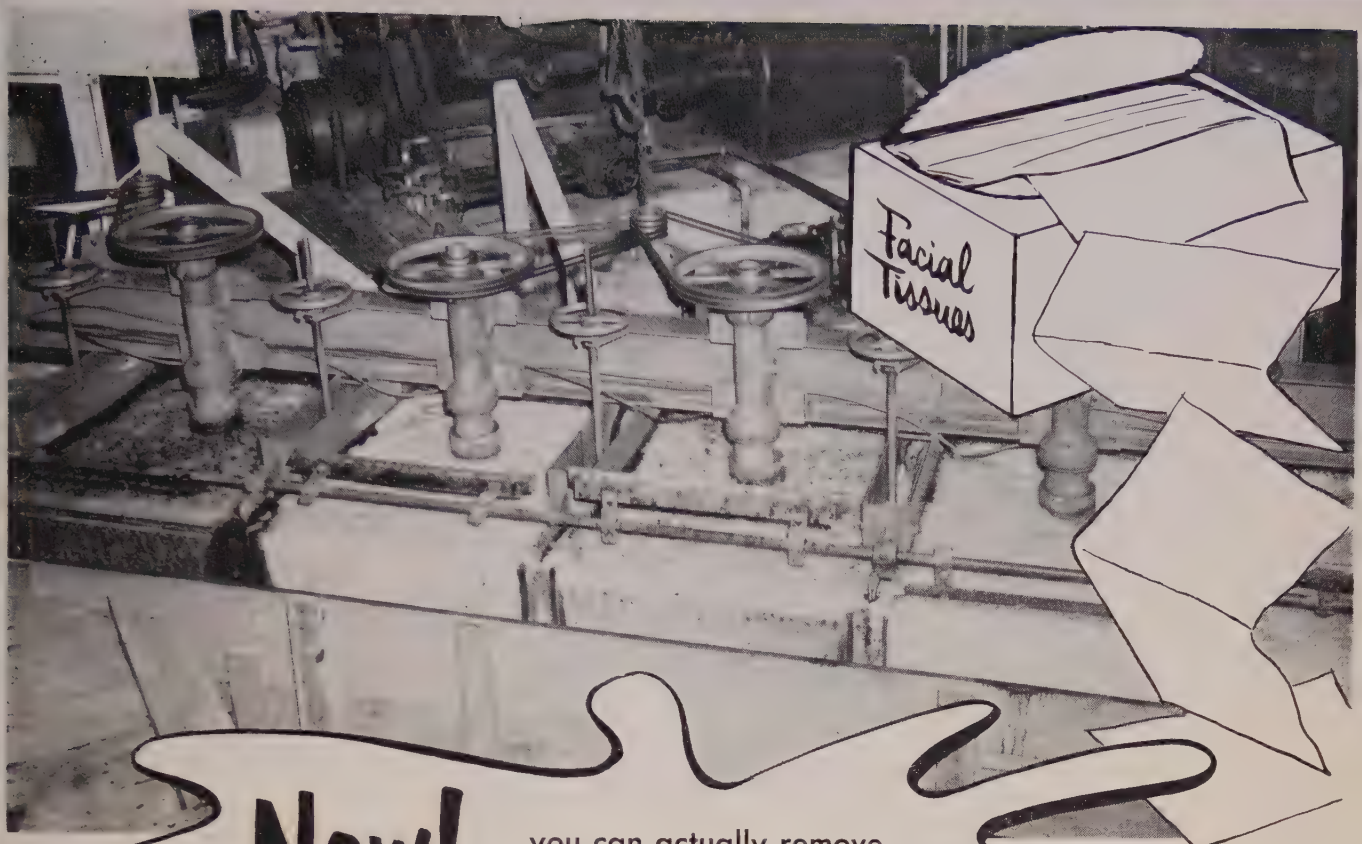

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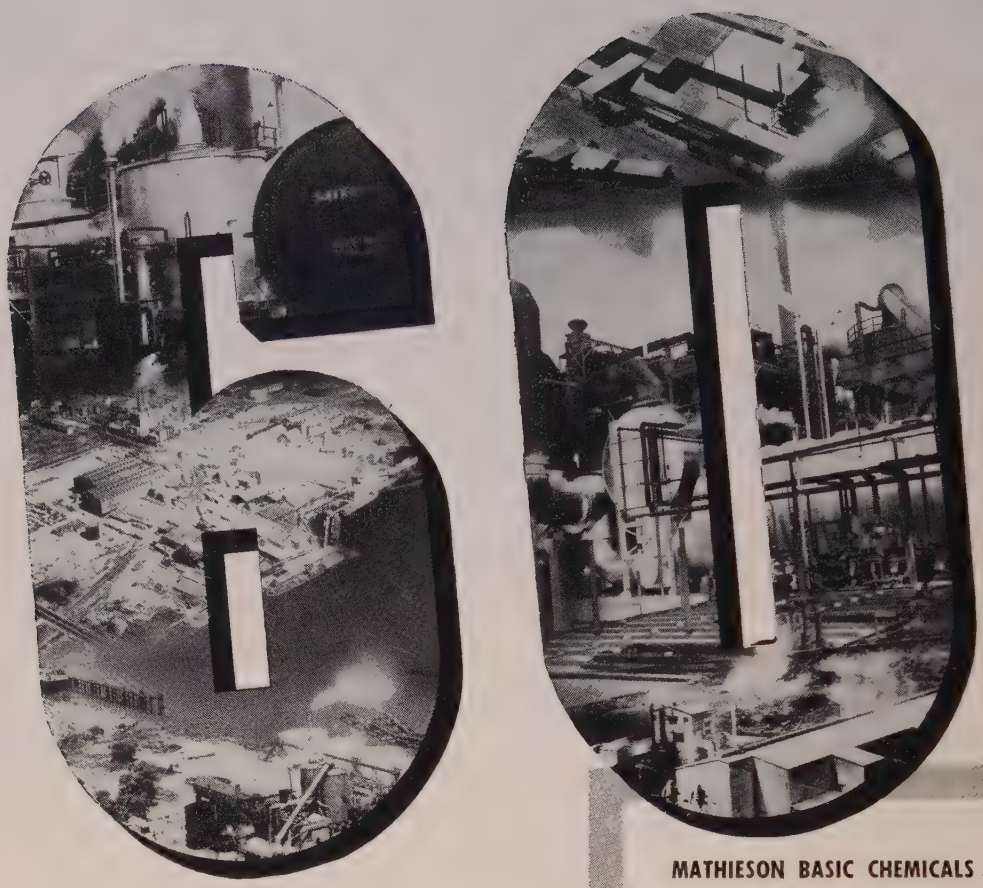

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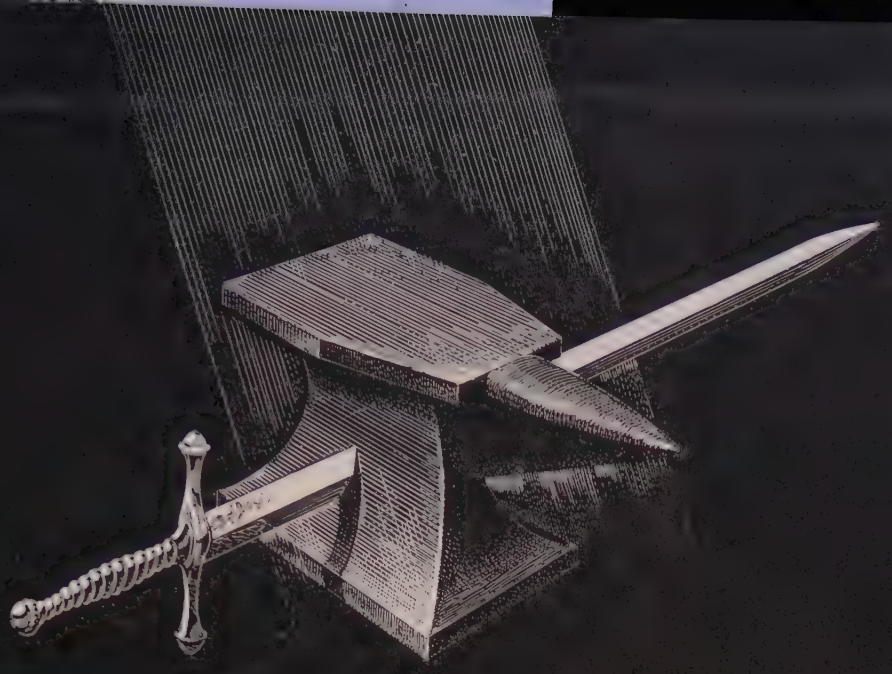

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Coal and Ash Handling

DONALD M. GIVEN, JR., and CARL A. MARSHALL

THROUGH the efforts of the bituminous coal industry to improve consumer satisfaction with coal, consultants and plant engineers as well as equipment manufacturers have been sold on the concept of fuel flexibility to the extent that, under certain market conditions, marketers of other fuels have been able to turn this situation to their own advantage. It has long been recognized that the performance of coal in a well-designed furnace is equal to or better than that of other fuels, but there has been a problem of materials handling (coal and ashes) which has mitigated against coal at an alarming frequency. This need not be the case, for there is adequate handling equipment available to provide cleanliness and labor-saving convenience in all sizes of boiler plants, at a reasonable cost.

The notoriously poor conditions under which coal is used in a number of existing plants can hardly be blamed on the coal. Rather, the fault lies in the selection of equipment for burning the coal, or the methods used in coal unloading and storing and the handling of ashes. Many consumers who encounter difficulties with certain types of coal are in the position of having bought equipment without specifying the range of coals they might wish to use. The consumer should particularly require equipment suppliers to guarantee performance on the basis of the type of coal most likely to represent the lowest long-term delivered B.t.u. cost, as indicated by the analyses of a coal in the table. Boiler operators are blamed for many troubles which could have been avoided, in most cases, if there had been adequate coordination of equipment selection, particularly in providing suitable combustion controls and instruments, as well as sufficient boiler capacity and draft. Plant engineers can design a boiler plant properly if they will give the matter adequate study. However, more and more consumers are coming to recognize the importance of employing an experienced consulting engineer to coordinate the selection and installation of all boiler-room equipment for maximum over-all economy and operating satisfaction.

The multiplicity of handling equipment available to accommodate all sizes of plants presents a certain amount of confusion and an almost unlimited degree of individual interpretation with regard to designing a handling system for an individual plant. Standardized design patterns for plants with comparable coal consumption offer important opportunities for clarifying as well as simplifying the problem.

Potential customers for handling equipment are easily discouraged by the poor performance of many existing installations, and they are even more discouraged when, as so often happens, they receive proposals requiring an investment entirely out of proportion to the size of their plant. Economy in fixed charges is just as essential as economy in labor and maintenance costs for materials handling. Automaticity and equipment reliability are essential also, as is the need for alleviating drudgery and dust nuisance. The much-improved status of labor in this country demands intelligent mechanization of menial jobs, not only for economy but also for good labor relations and efficient boiler-room operation.

Proximate		*Ultimate*	
Moisture, %	5.5	C, %	74.4
Volatile, %	35.5	H_2, %	5.0
Fixed carbon, %	50.1		
Ash, %	8.9	O_2, %	5.9
Sulphur, %	3.5	N_2, %	1.6
B.t.u. as fired	13,200	Ash, %	9.4
Ash softening temp., °F.	2050	S, %	3.7
Grindability (Hardgrove)	55	Fe_2O_3 in ash, %	30.0

The materials-handling problem is inherently subject to widely varying interpretation unless everyone concerned takes a realistic approach to the matter of limiting the equipment investment, whereupon more or less standard patterns begin to evolve. In some cases, the plant operators or plant management are inclined to exaggerate their handling requirements or suggest seemingly minor refinements without realizing how quickly investment costs can pyramid.

FUNDAMENTAL CONSIDERATIONS

All considerations of handling costs and required equipment capacities must be based on the rate of coal consumption rather than on boiler capacity. In the case of a new plant, coal consumption may be estimated from Fig. 1, using the appropriate load factors as indicated. The load factor is a percentage of the maximum steam load (not of boiler capacity) representing

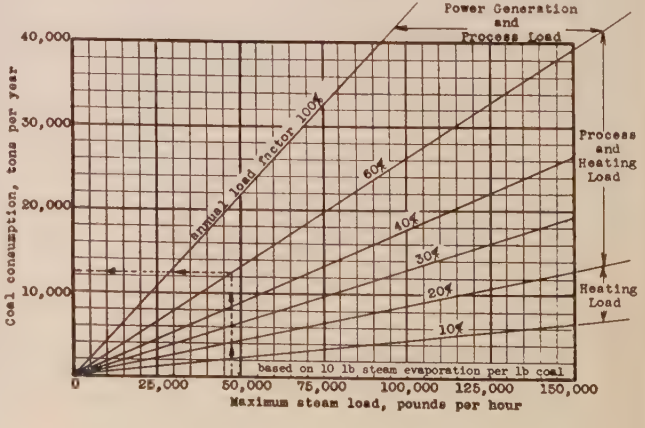

Fig. 1. Estimating annual coal consumption

"Reference Bulletin," No. 14 (Dec., 1951).

DONALD M. GIVEN, JR., Fuel Engineer, and CARL A. MARSHALL, Managing Director, Fairmont Coal Bureau, 122 E 42nd St., New York, N. Y.

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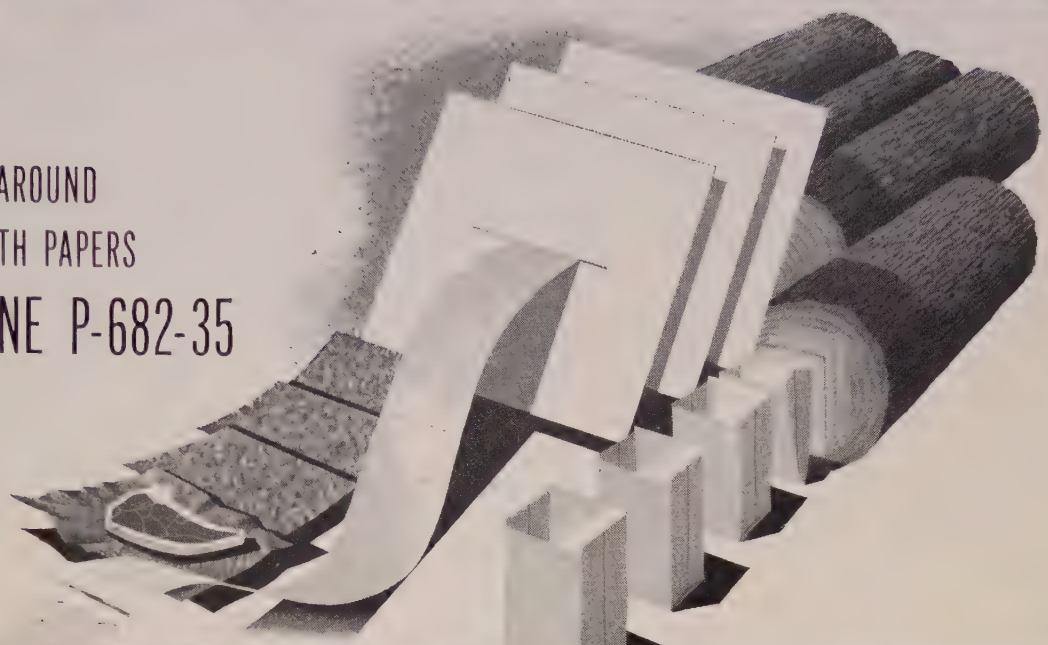

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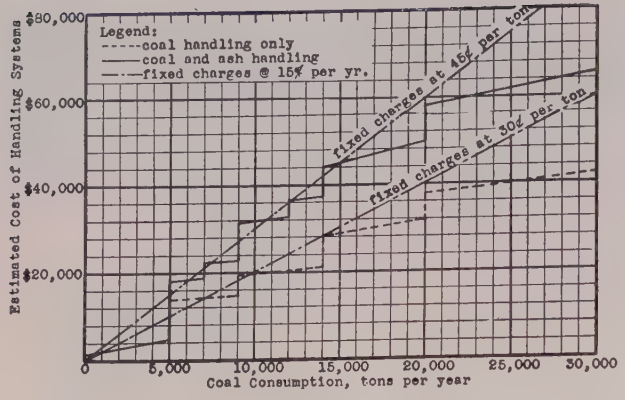


Fig. 2. Typical erected costs of well-designed handling systems

the average steaming rate for the full 8760 hr. in a year.

The total cost of handling coal and ashes in any size of plant can and should be controlled at from \$0.50 to \$1.00 per ton of coal consumption, including fixed charges and maintenance of equipment as well as labor costs. By comparison, the cost of handling heavy oil is almost identical. Pumping and heating costs of $4^1/_2$ to 5 cents per barrel, plus 3 to 6 cents for equipment maintenance, and 7 to 10 cents for fixed charges on the oil-handling and storage equipment, for different sizes of plants, make a total of $14^1/_2$ to 21 cents per barrel for handling residual oil. With 1 ton of 13,500 B.t.u. coal equal to $4^1/_3$ barrels of oil (148,000 B.t.u. per gal.), the oil-handling charges become \$0.63 to \$0.91 per equivalent ton of coal.

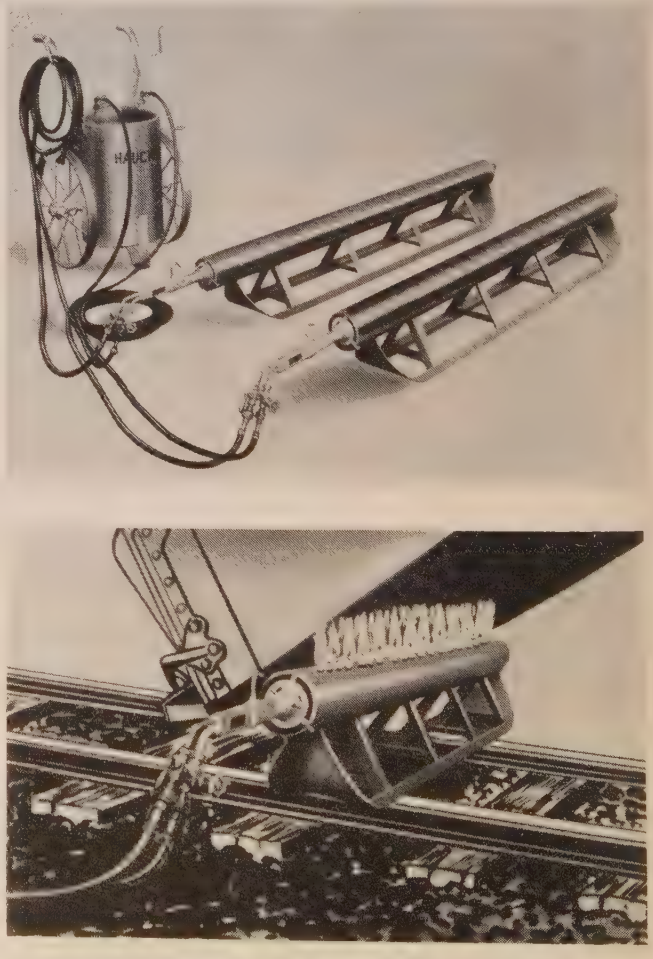
INVESTMENT COSTS

Figure 2 indicates typical erected costs of coal and ash-handling systems recommended for various sizes of plants. Each break in the cost curves indicates a recommended change in the type of equipment selected. As an example, the \$7000 increase at the 15,000-ton-per-year plant size primarily reflects a change in the type of coal-storage silo from concrete-stave to tile. Smaller plants using a tile silo would incur higher fixed charges which can be determined by ignoring this break and extending the upper curve back to the left. All costs shown in Fig. 2 are intended to minimize unnecessary frills, whereby optimum over-all economy and convenience may be obtained. Where the equipment selected is more elaborate than necessary, fixed charges will be increased accordingly, and over-all handling costs may then exceed \$1.00 per ton of coal consumption.

LABOR COSTS

All coal and ash handling inside the boiler room should be accomplished by the boiler operator without assistance, and without neglecting his other duties. The break in the cost curves of Fig. 2 at the 5000-ton-per-year plant size represents the point at which push-button control of coal handling inside the boiler room becomes economical. Automatic ash-handling systems start at the 9000 ton-per-year plant size in Fig. 2. In smaller plants the boiler operator is provided with handling equipment requiring occasional attention and a limited amount of labor. Coal handling outside the plant involves unloading coal cars (unless coal is delivered by truck) as well as movement to and from ground storage. Adequate storage capacity in a silo or bunker (usually a 1-week supply of coal) eliminates the need for drawing from ground storage except in emergencies, and reduces labor costs for handling reserve coal. The Bartgis Brothers Co., Ilchester, Md., keeps its coal pile a quarter-mile from the plant and draws on it only in case of emergency, because silo storage is provided for 700 tons with annual consumption of 30,000 tons. Once a year, they hire a man with a bulldozer to turn the pile over and compact it as a precaution against fires. A plant of the same size in New Jersey has overhead bunkers for only a one-day supply of coal so that their ground storage pile is continually being disturbed, causing frequent fires, much dust, and extra labor costs. Moreover, the installed cost of the one-day bunkers was approximately the same as for one-week silos.

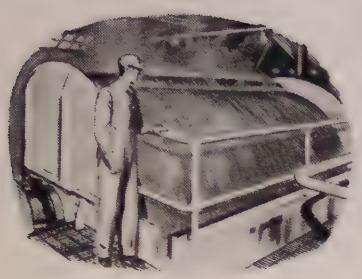
Labor costs for unloading coal cars vary from \$0.06 to \$0.12 per ton based on \$1.50 per man-hour and 2 to 4 man-hours per 50-ton car, as applicable in plants burning less than 30,000 tons per year (12 cars per week or less). However, this constitutes only a part-time job for one man in these plant sizes. When, as is frequently the case, one or even two men are assigned to the boiler room full time for unloading cars and odd jobs, over-all labor charges for the boiler room are substantially increased. Table I shows the extra cost per ton for



Courtesy Hauck Mfg. Co

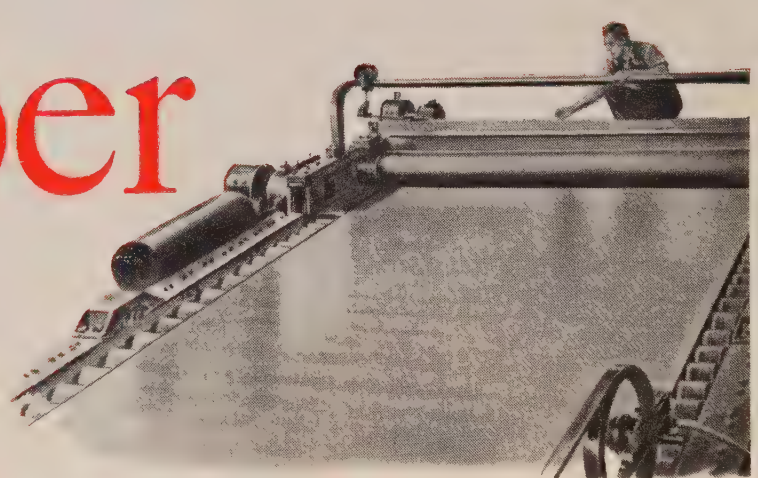
Fig. 3. Portable car thawing equipment

Kill slime,



from pulp

to paper



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BETTER THINGS FOR BETTER LIVING
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full-time extra labor. Under no conditions should the extra man be charged against unloading coal cars in excess of $0.24 per ton, which value covers at least twice the amount of time spent on unloading coal. Ideally, and many plants do it, the labor for unloading coal cars is obtained on a part-time basis from a central labor pool in the same way that maintenance men are used part time throughout factories and in up-to-date boiler rooms.

A portable car-thawing unit, as shown in Fig. 3, is an economical investment at $262 for any size of plant where frozen coal is encountered. Thawing pits at an erected cost of $1500 per unit (one unit required per car hopper) are recommended for large plants. Either type of equipment will thaw a car in less than 1 hr.

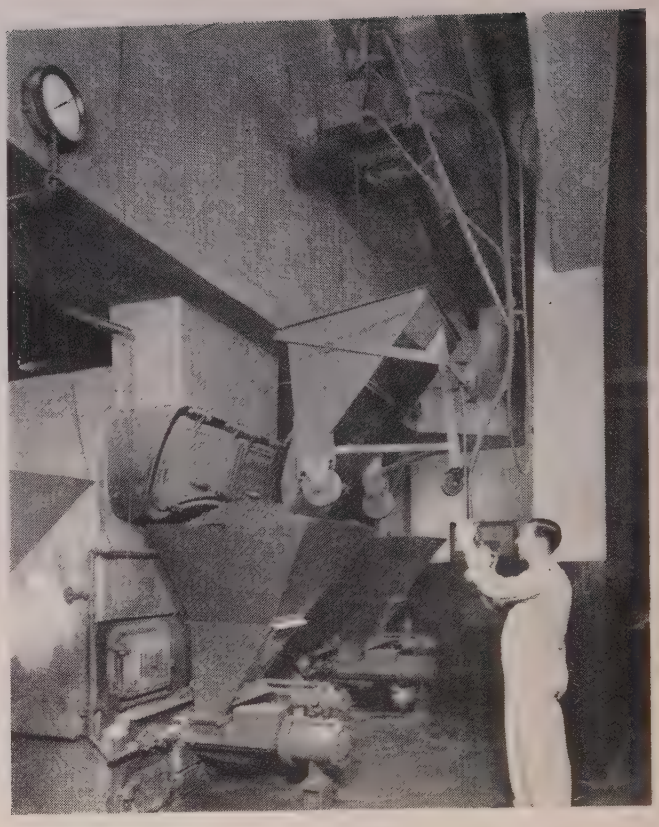
Courtesy National Conveyor and Supply Co.

Fig. 4. Inexpensive car shaker

The car shaker shown in Fig. 4 costs $1700 complete with hoist or dolly for moving it into position. Its nominal cost recommends it for plants burning more than 15,000 tons per year and even for some of the smaller plants where it is desired to minimize drudgery. Heavy-duty car shakers cost $12,000 and up, installed, but are primarily intended for the largest plants. None of the car shakers will eliminate the need for thawing a car of frozen coal, but all of them will empty a car "broom clean" in less than 15 min., if the conveyors can move the coal away that fast. Conveyor capacities of only 25 to 50 tons per hr. are recommended for the plant sizes shown in Fig. 2, necessitating that the shaker be started and stopped several times in unloading a car, regardless of shaker capacity.

Table I. Labor Costs per Ton of Coal Consumption Based on Wage Rate of $3600 per Man-Year

Tons coal used per yr.	*1 Extra man*	*2 Extra men*	*3 Extra men*
1,500	$2.40	$4.80	$7.20
6,000	$0.60	$1.20	$1.80
10,000	$0.36	$0.72	$1.08
15,000	$0.24	$0.48	$0.72
20,000	$0.18	$0.36	$0.54
30,000	$0.12	$0.24	$0.36



Courtesy Detroit Hoist and Machine Co.

Fig. 5. Mobile coal and ash bucket with monorail hoist

MAINTENANCE COSTS

Reliability of handling equipment is essential, requiring not only sturdy equipment but also good preventive maintenance. The actual maintenance costs

Courtesy Clark Equipment Co.

Fig. 6. Lift truck with scoop bucket

"BUILT TO THE SAME SPECIFICATION STANDARDS – I THOUGHT ALL STEEL VALVES WERE ALIKE AS TWO PEAS"

OIC BUILDS FROM THAT POINT UP

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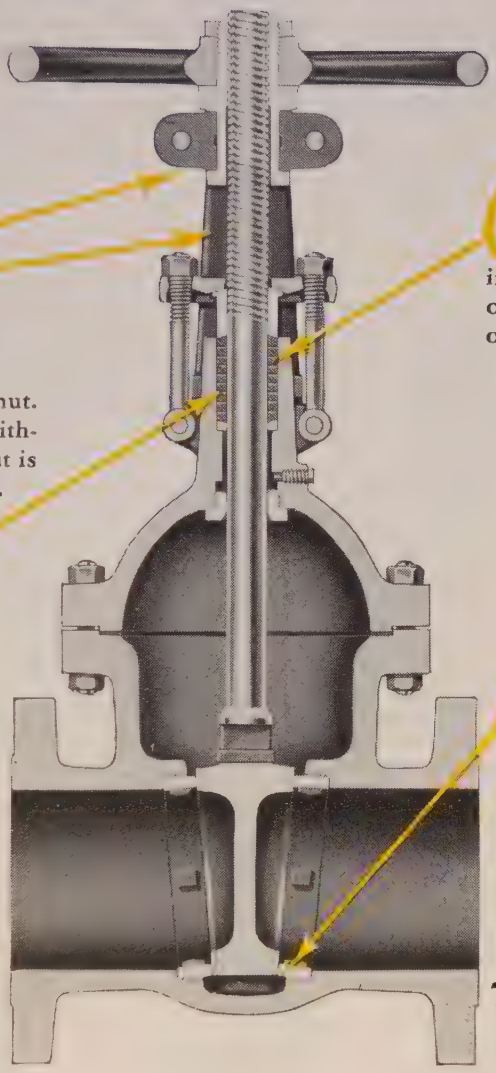

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should average from about 10 to 25 cents per ton, being greater in the small plants by virtue of higher unit costs rather than because of any difference in equipment sturdiness.

SUMMARY OF HANDLING COSTS

Maximum fixed charges shown in Fig. 2 are about $0.50 per ton of coal consumption, as defined by a maximum investment rate of $3.33 per annual ton of coal consumption and a fixed charge rate of 15%. Maximum labor charges of $0.24 per ton and maximum maintenance charges of $0.25 per ton verify the earlier statement that total handling charges need not exceed $1.00 per ton of coal consumption. Many existing installations could profitably be modified or even completely replaced where labor and maintenance charges are excessive. Installation of large-capacity silos to augment or replace small-capacity bunkers is indicated in a great number of plants. Management must be convinced, however, that these improvements are warranted before their approval can be expected.

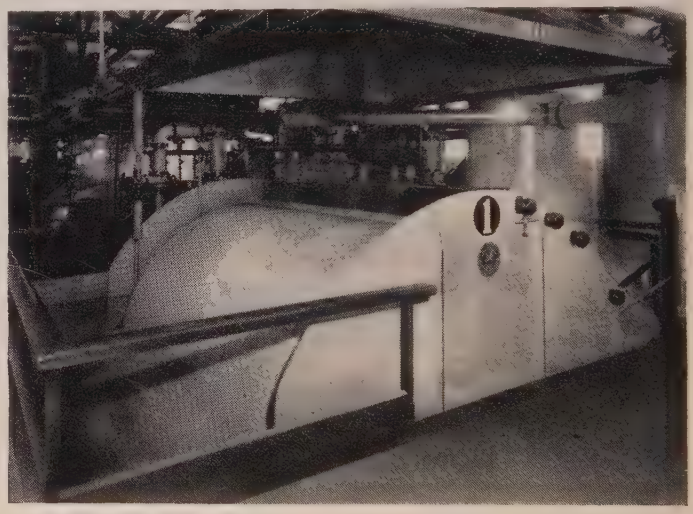
TYPICAL INSTALLATIONS UNDER $5000

Monorail Hoist

Figure 5 shows a simple monorail-hoist system available at an installed cost of from $600 to $900. The coal and ash bucket mounted on wheels is pushed to the coal pile and loaded either by hand or by gravity from an elevated bin. It is then wheeled to the boilers, hoisted, moved over the stoker hoppers, and dumped. Extending the monorail only over the stoker hoppers eliminates the need for elaborate engineering layouts and for track electrification. This same type of system is recommended for ash handling in many of the smaller plants. Bucket capacities to 700 lb. are practical. Stoker hoppers can be increased in size as desired.

Lift Truck

Figure 6 shows an industrial lift truck with scoop



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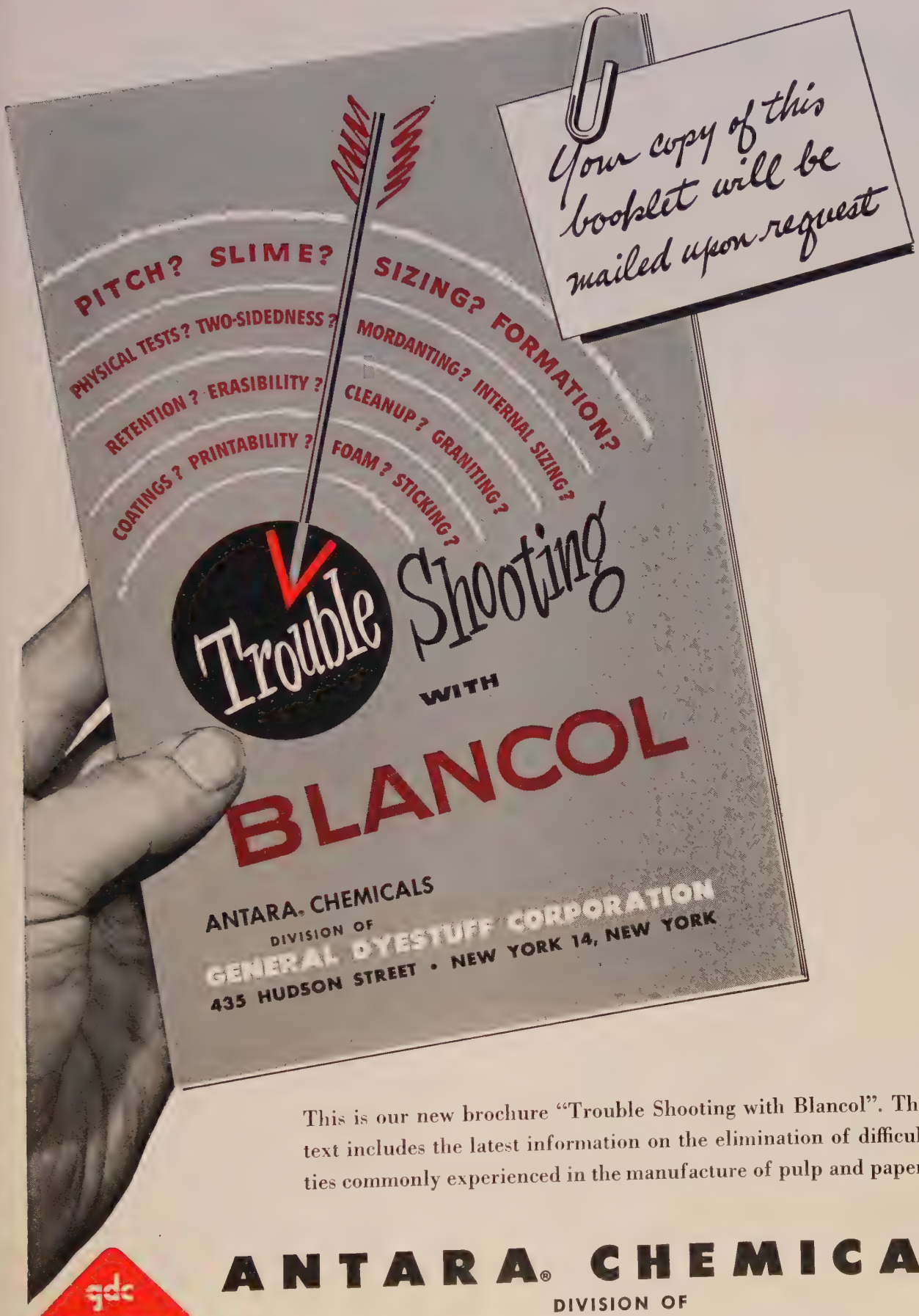

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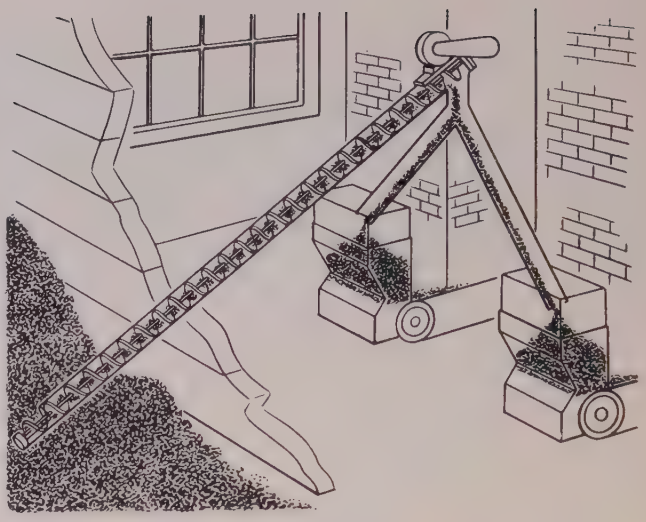
Courtesy Towmotor Corp.

Fig. 7. Pneumatic-tired lift truck



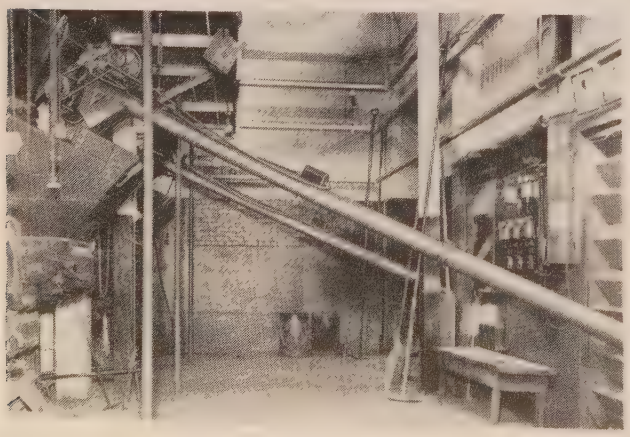
Courtesy Baughman Mfg. Co.

Fig. 9. Screw feeder serving two stokers

bucket, and incorporating a crowding action to facilitate filling the bucket. Coal is scooped up from a pile either inside or just outside the boiler room and delivered directly to the stoker hopper. Ashes are handled in a similar manner. The type of truck shown with 750 lb. bucket capacity costs from $2800 to $3300. Pneumatic-tired models (Fig. 7) are recommended for outside work, to minimize tire maintenance and improve traction. These cost $3700 with 1000-lb. bucket and $4500 with 2000-lb capacity. The larger models require wider aisle space. Bucket capacity with both the monorail-hoist and the industrial-truck systems should be such as to require not more than one or possibly two trips per hour, depending on the fireman's ability to handle coal and ashes without neglecting boiler operation.

Bin-to-Stoker Feeder

Figures 8 and 9 illustrate a simple enclosed conveyor of either the screw or flight type, offering laborless and dustless feeding of coal from storage bin to stoker hoppers. One conveyor can be used for two stokers, if desired. Total erected costs, not including the storage bin, approximate $800 to $1500 per conveyor, depending on the length and diameter. Slow-speed operation and surplus conveyor capacity are recommended for the screw-type conveyors to help offset their relatively high maintenance. Coal-limit switches may be added for $80 per conveyor, to make the conveyor operation automatic.



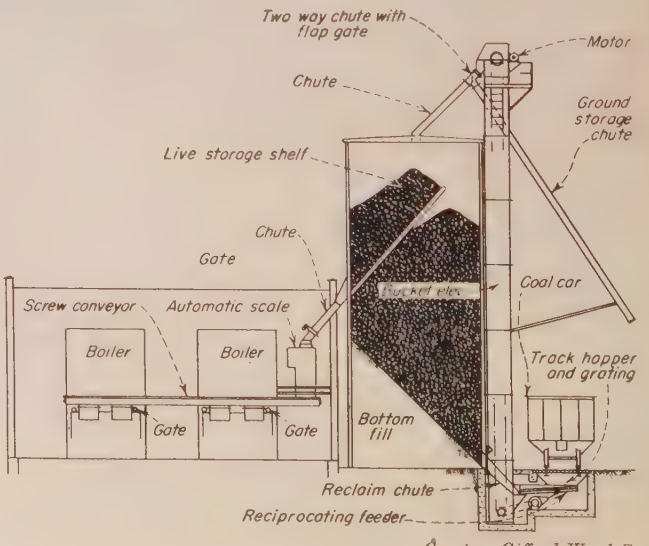
Courtesy Hager Bros. Co.

Fig. 8. Bin-to-stoker conveyor

STATIONARY COAL-HANDLING SYSTEMS

Figure 10 illustrates a system for push-button handling of coal from track to stoker hopper, completely enclosed to eliminate dust. Coal is unloaded into the track hopper and moved by the reciprocating feeder and bucket elevator to the silo, filling the live-storage shelf and spilling over into the reserve storage space. From there it is later reclaimed with the bucket elevator to the live-storage shelf. Gravity feed from the live-storage shelf to the automatic scales and thence by screw conveyor to the stoker hoppers completes the cycle.

This type of system is quite flexible in application, as illustrated by variations shown in Figs. 11, 12, and 13. The portable car unloading system of Fig. 12 saves at least $3000 as compared with the undertrack hopper and feeder of Fig. 10. Feeders from the under-track



Courtesy Gifford-Wood Co.

Fig. 10. Push-button system for handling coal

EASILY HANDLES 3000 POUNDS OF BROKE PER HOUR
on an economical 35-40-h.p.

No. 1 E.D. Jones Pulp-Master

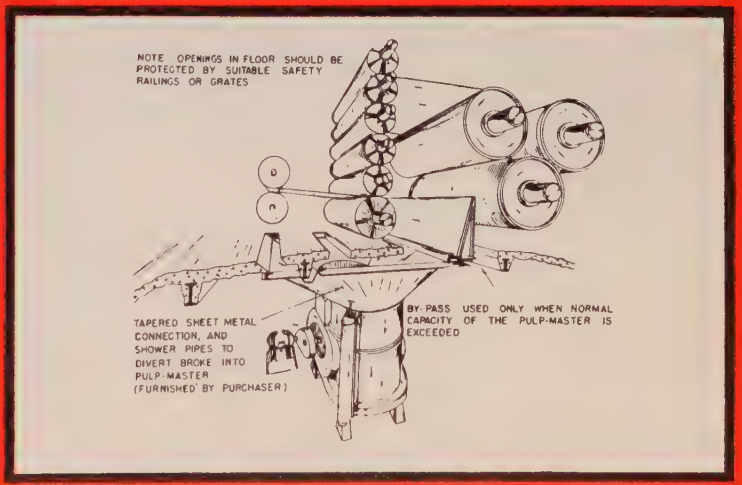
Ideal for installation under your paper machine, the Jones No. 1 Pulp-Master will easily handle 3000 lbs. of broke per hour, extracting completely pulped stock continuously through non-clogging perforated plates. *Slabs?* — sure, slabs up to the full width of your machine can be dropped or thrown in, and are almost instantly disintegrated.

Simple and fool-proof in design and operation, it requires no operators beyond the regular machine crew, and is free from troublesome maintenance problems. Power consumption, an economical 35 to 40 h.p.

Three other sizes of Jones Pulp-Master are available with capacities up to 4000 lbs. at 6½% or even higher densities, for batch or continuous operation.

Illustrated above in stainless steel, the No. 1 Pulp-Master is also available in regular carbon steel or for economical tile tank construction.

Delivered completely assembled, it is readily anchored in position (see suggested plan at right), piped up and connected to driving motor, ready to do a truly amazing job of pulping broke continuously.


NOTE: OPENINGS IN FLOOR SHOULD BE PROTECTED BY SUITABLE SAFETY RAILINGS OR GRATES
TAPERED SHEET METAL CONNECTION, AND SHOWER PIPES TO DIVERT BROKE INTO PULP-MASTER (FURNISHED BY PURCHASER)
BY-PASS USED ONLY WHEN NORMAL CAPACITY OF THE PULP-MASTER IS EXCEEDED

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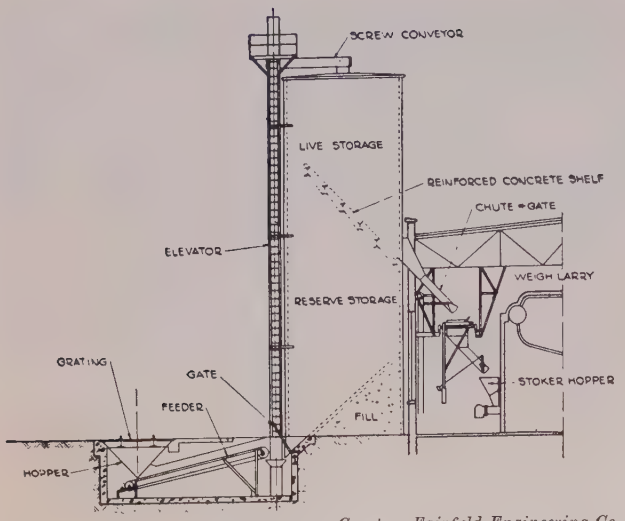
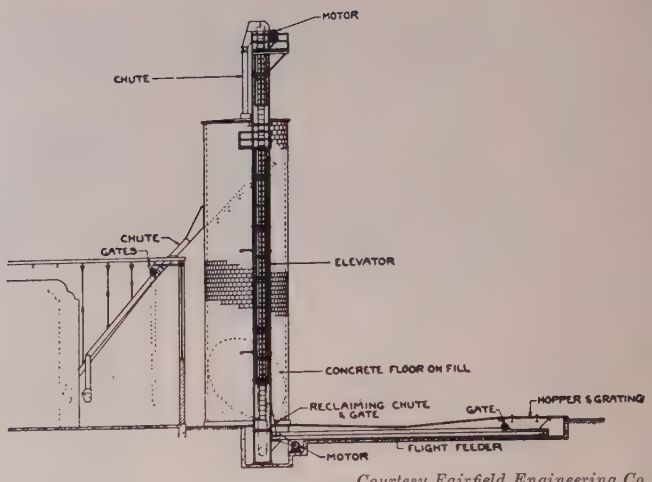


Courtesy Fairfield Engineering Co.

Fig. 11. Silo system with weigh larry



Courtesy Fairfield Engineering Co.

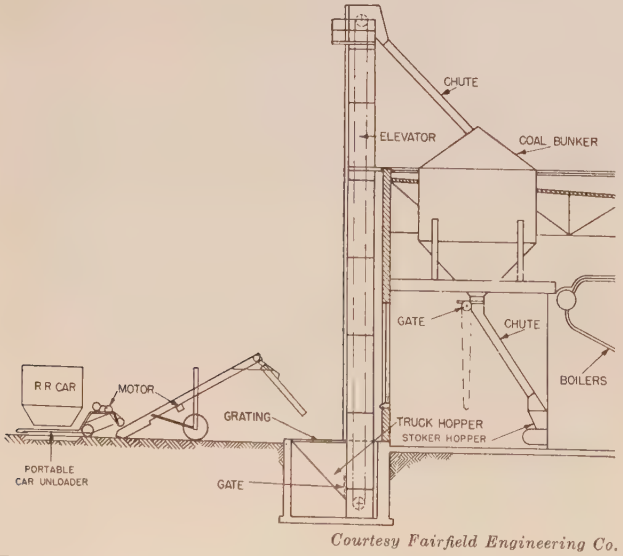
Fig. 13. Silo system with gravity chutes to stokers—long feeder in shallow trench from track hopper

hopper can be selected in any length to suit the space conditions, but should be brought partly above ground wherever practical to minimize trench construction. Cylindrical bunkers may be substituted for the silo where space limitations favor coal-storage location on the boiler-house roof. A weigh larry or monorail bucket is a suitable substitute for the screw conveyor feeding the stoker hoppers, and in some cases simple gravity chutes may be used. The actual details of fitting this system to particular space conditions are academic, but it is quite important to consider other factors which fundamentally affect the over-all economy and convenience of handling the coal.

Conveyor capacities from track to silo control the rate at which the coal cars can be unloaded. A 25-ton-per-hr. capacity or 2 hr. per 50-ton car is ideal for the small plants. Plants burning from 20,000 to 30,000 tons per year should have 50-ton-per-hr. unloading. Excess conveyor capacity unnecessarily increases investment as well as maintenance costs.

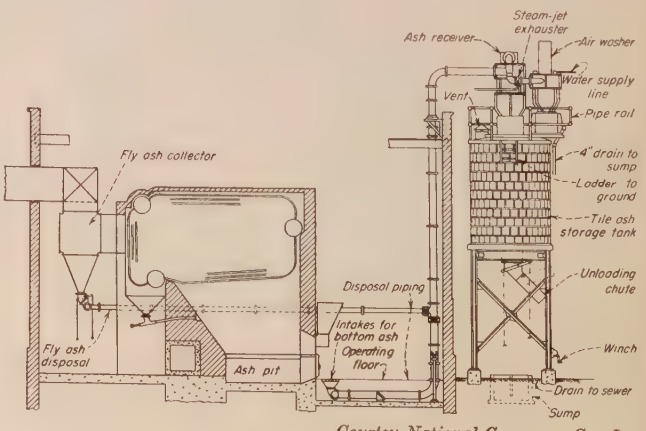
Silo capacity should be equivalent in most cases to a one-week supply of coal but no less than 100 tons, to eliminate the need for drawing from ground storage except in emergency, thereby saving labor and the troubles invariably encountered when a coal pile is continually disturbed (double-screened coal excepted). Most complaints of wet coal are traceable to the conditions encountered in handling coal to and from a storage pile, although some of the marginal coal producers are not always too careful about controlling moisture in their coal. The moisture picked up in transit from the mine is negligible because when coal containing slack sizes is piled on the ground or in a car, rain does not penetrate more than a few inches from the surface of the pile.

Two or as many as four silos can be used with one bucket elevator, permitting economical additions to silo capacity when and if the plant load increases. Concrete-stave construction is recommended for small plants because tile or monolithic construction just about doubles the cost of the silo, without appreciable advantage in the small plant other than improved appearance. Steel bunkers cost four or five times as much as a concrete-stave silo on an erected basis, for equivalent storage capacity. Cylindrical steel bunkers for 100 to 150 tons capacity are practical where a roof location is necessary. Suspension-type bunkers are



Courtesy Fairfield Engineering Co.

Fig. 12. Coal handling with portable car unloader and roof bunker

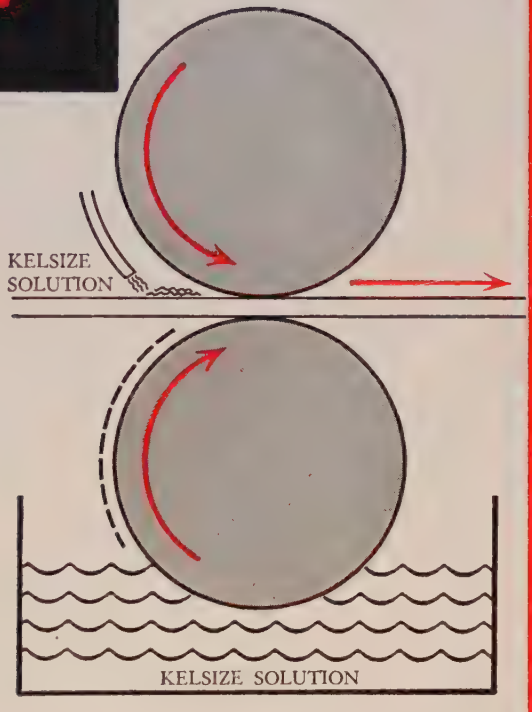


Courtesy National Conveyors Co., Inc

Fig. 14. Pneumatic ash handling system

KELSIZE and KELGIN

Kelsize and Kelgin are applied as a 0.2% to 3.5% solution from calender stack or size press.



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For Better Results On

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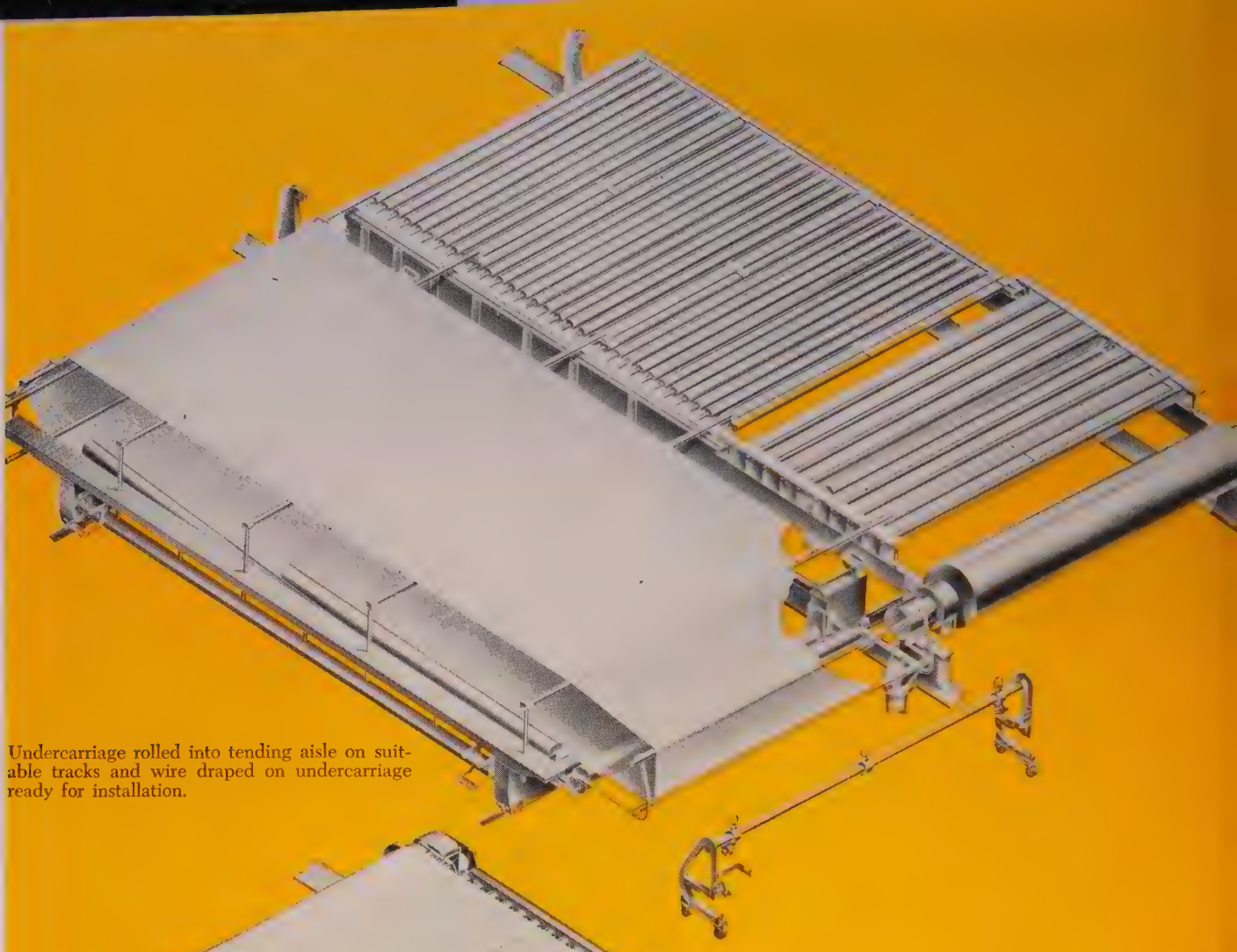
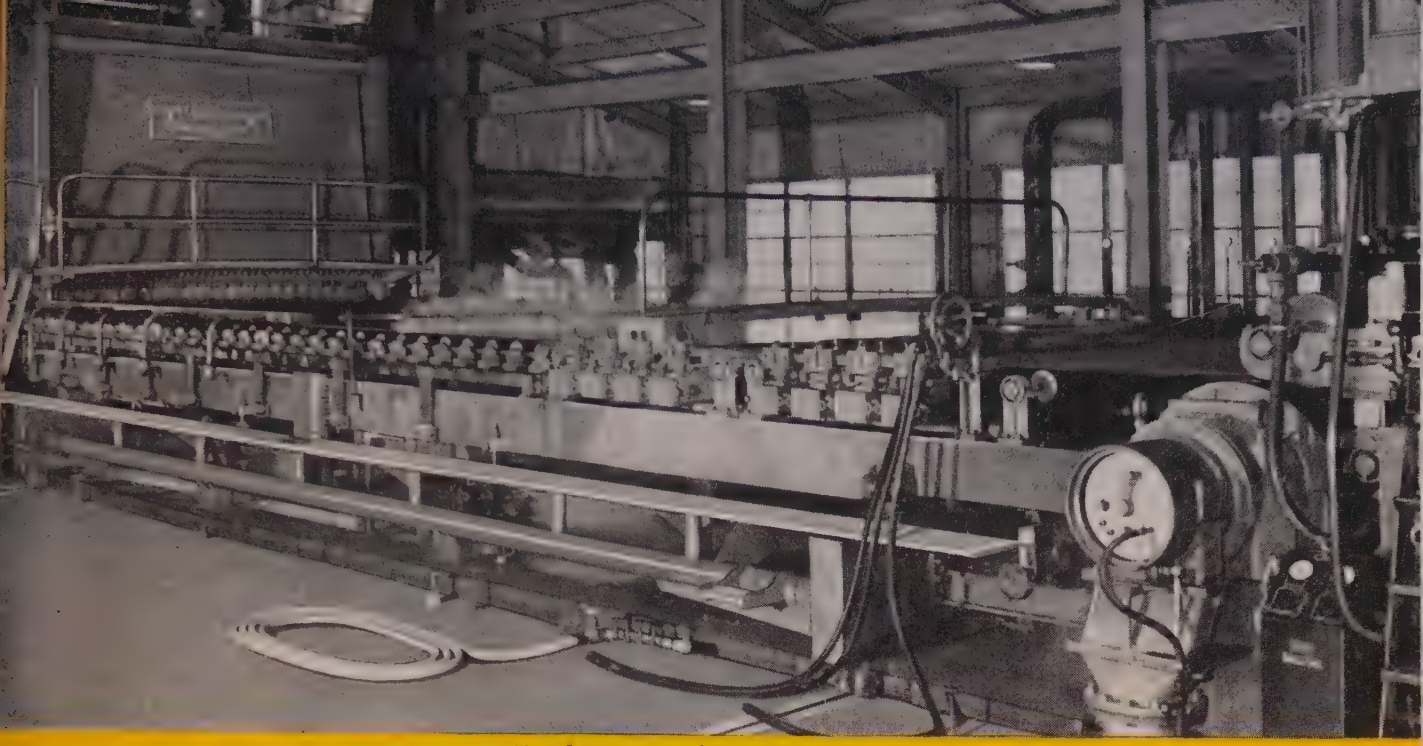


Undercarriage rolled into tending aisle on suitable tracks and wire draped on undercarriage ready for installation.

Fourdrinier part with wire installed ready for operation.



Fourdrinier part of "Rapi-Drape" design.

"RAPI-DRAPE" Scores Again

"Rapi-Drape" Wire Handling is now being used successfully in these outstanding mills:

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Union Bag & Paper Corp., Savannah, Ga. (2)
Hudson Pulp & Paper Corp., Palatka, Florida (2)
Southern Paper Board Corp., Port Wentworth, Ga.
Fibreboard Products Inc., East Antioch, Calif.
St. Regis Paper Co., Tacoma, Wash.
Calcasieu Paper Co., Elizabeth, La.
San Rafael Paper Co., Mexico, D. F.
Papierfabrik Utzenstorf, Switzerland
National Newsprint Co., Ltd., India
Container Corp. of America, Cali, Colombia, S. A.
Brown Paper Mill Co., Monroe, La.

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Union Bag & Paper Corp., Savannah, Ga.
St. Joe Paper Co., Port St. Joe, Fla.
West Tacoma Newsprint Co., Tacoma, Wash.
Fraser Paper, Ltd., Madawaska, Me.
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One of the largest southern mills reports a complete wire changing record of 65 minutes down-time from reel to reel. This particular fourdrinier wet end is equipped with wire 236" wide and 120 ft. long.

In addition to all new Puseyjones machines equipped with this efficient wire changing device, the mills have found it profitable to change over old machines due to the many advantages obtained. Under construction at present are 3 fourdriniers, one 194", one 212" and one 220" wire width, equipped with "Rapi-drape" that will replace old style removable type originally supplied with each machine.

In "Rapi-drape" Wire Handling, pioneered by Puseyjones, the fourdrinier as a unit remains in the operating position. The back side of the fourdrinier is supported on rigid frames and the front side on a removable hydraulic power-operated under-carriage so that the fourdrinier is supported in perfect alignment at all times. It is unnecessary to detach the shake, suction boxes or shower piping. The only parts which must be removed are the dandy roll, deckle and cut squirts.

The results in terms of fast, safe wire handling are acclaimed by the many responsible operators and engineers who have this equipment in use. Be sure that your next machine is equipped with "Rapi-Drape" Wire Handling — one of many design improvements and labor-saving devices developed by Puseyjones.

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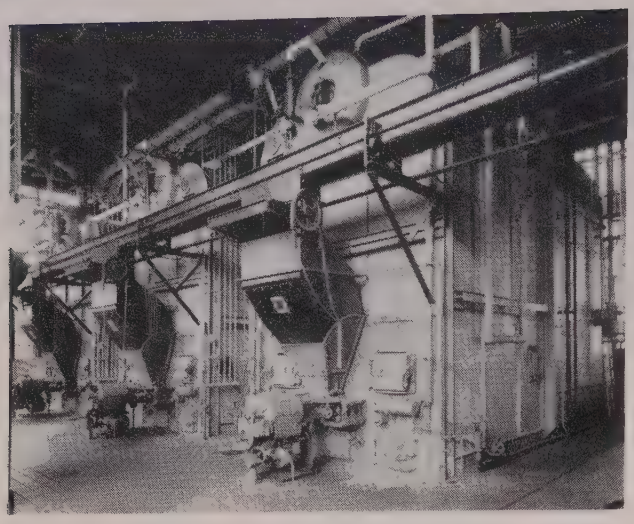


Courtesy P. H. Oppenheimer, Consulting Engineer

Fig. 15. Modern coal and ash handling at Thomas Young Orchids, Bound Brook, N. J. Note coal conveyor from silo, and ash intakes in front of boilers

usually a poor selection for any of the plant sizes considered here. They require increased boiler-room space and frequently create a dust nuisance and other inconveniences.

Silos are usually the best storage-bin selection where they can be accommodated. Nevertheless, the designers have often slipped up on the design of the live-storage shelf, causing troubles from spontaneous combustion and also from wet coal arching on the shelf. One plant in Virginia has a fire in the silo every six months because the live-storage shelf was made so large that the boiler operator seldom has occasion or the inclination to recirculate coal from the reserve-storage space. The live shelf should be designed to hold a one-day supply of coal which is sufficient to permit repairs to the bucket elevator, and small enough to make the operators recirculate coal from the reserve-storage space frequently. Also important in preventing fires are (1) a sloping bottom in the silo, and (2) air-tight gates at all openings below the coal level.

Arching on the live-storage shelf is mainly a function of moisture in the coal and design of the discharge opening. If the silo is large enough to prevent frequent drawing of coal from ground storage, excessive moisture can be avoided by changing coal suppliers. Steam coils have been placed around the openings in some silos, but there is no evidence that such devices are needed where the silo is properly designed. In any event, the silo can be designed without a live-storage shelf if elevated for satisfactory conveying from the bottom of the silo, or if an extra chute is provided at the top of the bucket elevator for feeding directly to a separate bunker (8 to 24 hr. storage capacity) which in turn feeds the stoker hoppers.

COAL WEIGHING

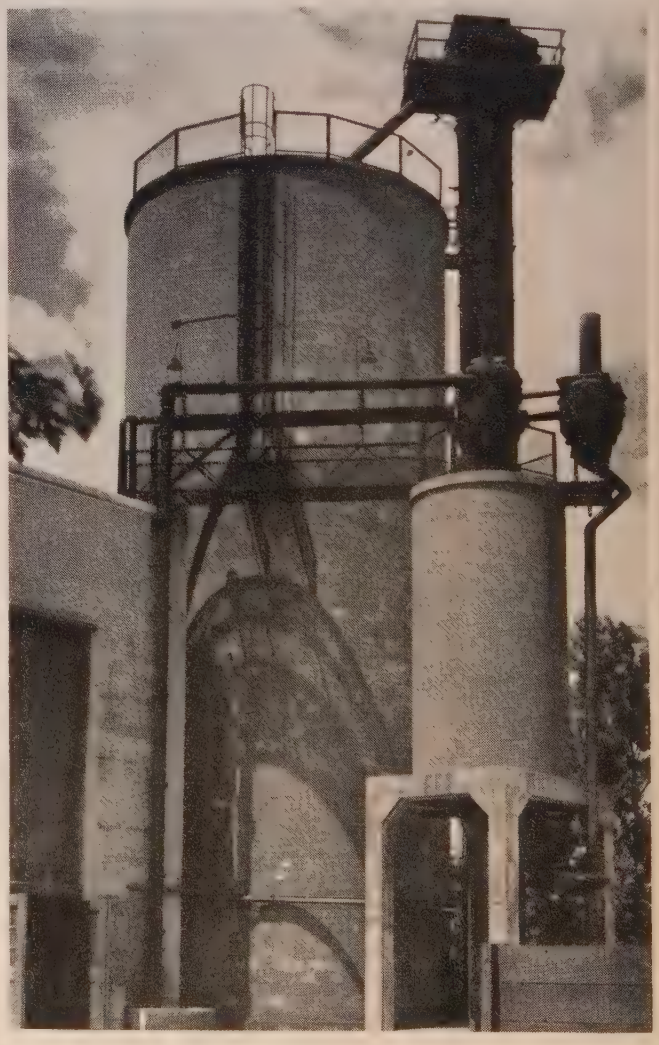
The only need for weighing the coal delivered to the boilers is for determining boiler efficiency. Hence, plants not equipped with steam-flow meters have no need for coal scales. Moreover, weekly or monthly estimates of the change in coal level in the silo compared with coal deliveries are sufficiently accurate for determining average efficiency. Weight larries are not always too accurate, and automatic scales are accurate only if properly maintained and adjusted. Small plants are often better off without scales.

GROUND STORAGE OF COAL

An important advantage of coal over other fuels results from the fact that it can be stored in unlimited quantities directly on the ground, as insurance against fuel shortages in an emergency. However, the wheels of industry are so dependent upon coal that most industrial plants could operate from their emergency coal supply only so long as their suppliers of raw materials still had fuel. Thus, the national average of 1 to 2 mo. supply of coal held by industrial plants would suggest an average size of reserve pile equivalent to about 2 mo. operation. As mentioned, this pile can be located at some distance from the plant when adequate silo or bunker storage is available.

ASH HANDLING

Conveyors used for handling coal are not always satisfactory for ash handling because of the highly abrasive characteristics of ash. Convenience in coal handling should take preference over ash handling,



Courtesy Fairfield Engineering Co.

Coal and ash silos at Curtiss-Wright, Propeller Div., Caldwell, N. J.

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What has this to do with Mersize? Only this: Naturally, the paper from which Sealright containers are made is all-important to the product. And, as with any paper, much of the final product's performance depends on the efficiency and uniformity of the sizing agent used. We think it is significant that the Oswego Falls Corporation, and many other mills supplying board for Sealright containers, use Mersize in their sizing operations.

If Mersize has improved their sizing results, chances are it will do the same for you.

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because of the larger quantities involved. Hoist buckets and other portable systems are ideal for small plants. Pneumatic or hydraulic sluicing systems for ash disposal start at $12,000 installed. If the ash cannot be sluiced to a fill area, decanting tanks are required which make sluicing systems excessive in cost for the plant sizes under consideration.

Figure 14 shows a pneumatic system with ash intakes for bottom ash, located directly in front of the boilers on the operating floor (see also Fig. 15). Ash is raked to these intakes and conveyed to the storage tank. Fly ash from dust collectors is removed with the same system. The system is energized only once or twice a shift, and can be operated by the fireman. All ash intakes should be gravity fed if not located on the operating floor and convenient to the fireman.

Air flow in the disposal system is normally produced by a steam-jet ejector, which should be arranged to prevent steam mixing with the ash and causing freezing troubles in the storage bin. The exhaust from the steam jet should be piped either to the stack or to a ash conditioner, and with the steam and air being exhausted to the stack. Substituting a tile storage bin and adding the dust collectors increases the erected cost to $16,000 (suitable for 15,000-ton-per-year plants). Ash conditioners add $10,000 or more and are seldom justified in plants burning less than 20,000 tons per year. Simple water sprays at the discharge chute are more practical and more easily maintained for smaller plants, and even these are not needed in many cases. High alloy piping is used in all of these systems to minimize erosion troubles, and all elbows have replaceable sections. Most systems are of either 6 or 8-in. diameter, making pipe selection for erosion resistance primarily a function of tons of ash to be handled per day.

COST OF SYSTEM RELATED TO PLANT SIZE

Table II summarizes the foregoing discussion with typical erected costs of complete handling systems well suited to specific sizes of plants. The cost data are predicated, of course, on average conditions and average

Table II. Typical Erected Costs of Handling Systems

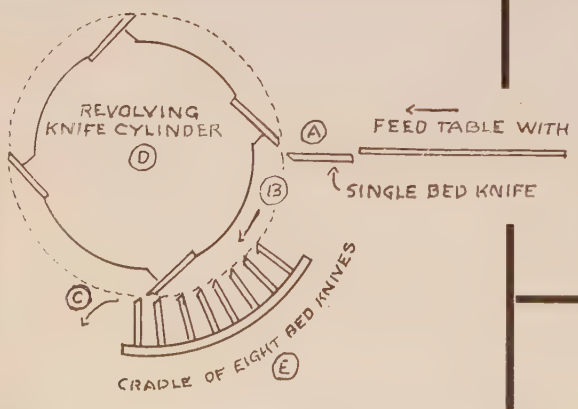
Plant size, tons/yr.	*Handling equipment*		*Silo capacity, tons*	*Elevator capacity, tons/hr.*	*Erected costs*		*Investment per annual ton of coal*
	Coal	*Ash*			*Coal*	*Ash*	
300	Monorail hoist		...	..	$800		$2.67
2,000	or bin feeder		...	..	$800 to $3,700		Under $1.85
5,000	or lift truck		...	..	$1,200 to $5,000		Under $1.00
6,000	Note (1)	Hoist	120	25	$14,000	$ 1,000	$2.50
9,000	Note (2)	Pneumatic	180	25	$18,000	$12,000	$3.33
12,000	Note (2)	Pneumatic	240	25	$20,000	$16,000	$3.00
15,000	Note (3)	Pneumatic	300	25	$29,000	$16,000	$3.00
30,000	Note (4)	Pneumatic	600	50	$42,000	$23,000	$2.17

Notes: (1) Silo system with portable car unloader, concrete-stave silo. (2) Silo system with under-track hopper, concrete-stave silo. (3) Silo system with tile silo, car shaker. (4) Silo system with tile silo, car shaker, automatic scales.

cyclone separator (ash receiver) and air washer atop the storage bin, to minimize the amount of ash discharged with the steam and air to the atmosphere. If fly ash is not being handled, these precautions may not be necessary. Another refinement is the rotary ash conditioner used in large plants at the bottom of the ash-storage bin to wet down the ash before it is discharged to trucks.

Some equipment suppliers offer $35,000 installations for the entire range of plant sizes being considered here but the small plants can be suitably equipped for $12,000 using a steel storage bin rather than tile, without wage rates for erection labor. The implied sacrifice of convenience for each successively smaller plant size is unimportant in view of the related reduction in quantity of materials to be handled.

This discussion is by no means intended to cover all of the different types and combinations of equipment that can be used in a specific size of plant. Rather, it represents an effort to shed some light on the coal and ash-handling problems whereby small-plant consumers may better appreciate some of the possibilities for approaching large-plant economy and convenience with a limited capital investment.



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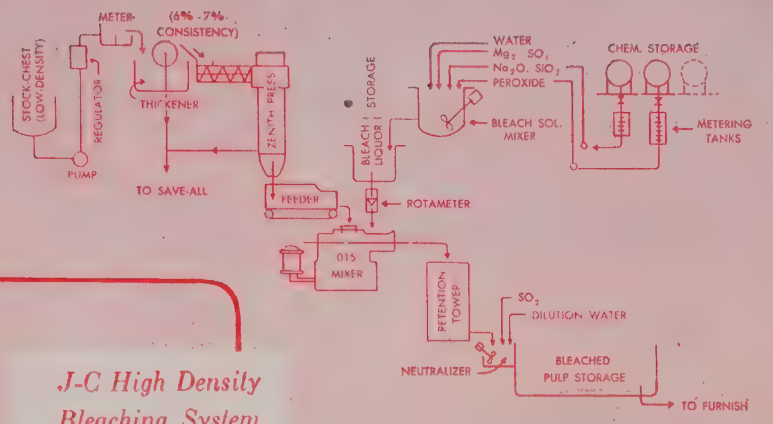

J-C High Density Bleaching System

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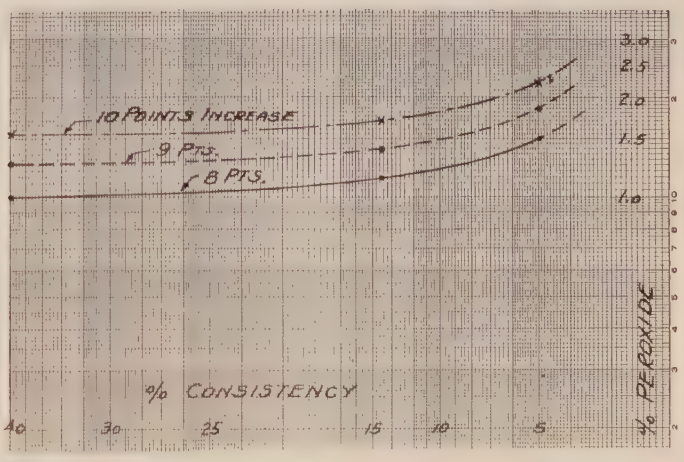
Recent tests performed under actual mill conditions proved savings of 12.8 pounds of bleach per ton of *groundwood* pulp. To a 100-ton plant this will mean a saving of 1,280 pounds of bleach in one day's operation by the High Density System, *or a saving in excess of $100,000 in a year.* Benefits from high density bleaching of sulphite pulp are comparatively greater.

The Jackson & Church High Density System incorporates the J-C Zenith Press and J-C Shredder Mixer because of their ability to handle high consistencies. Pulp mills are now able to realize substantial savings by changing from low density with its higher bleach costs.



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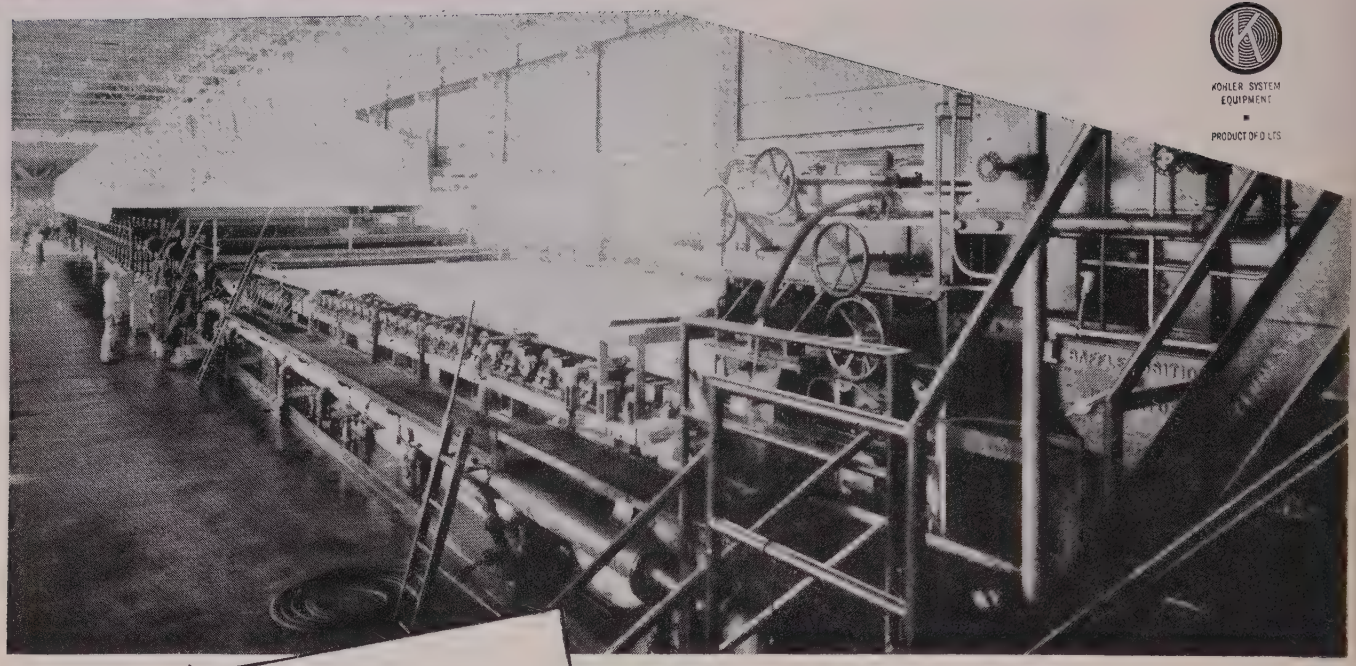

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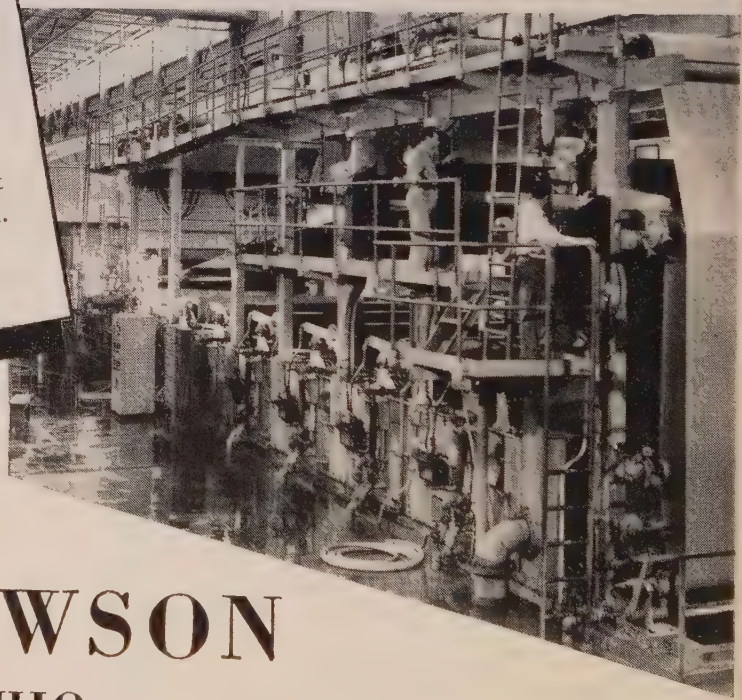

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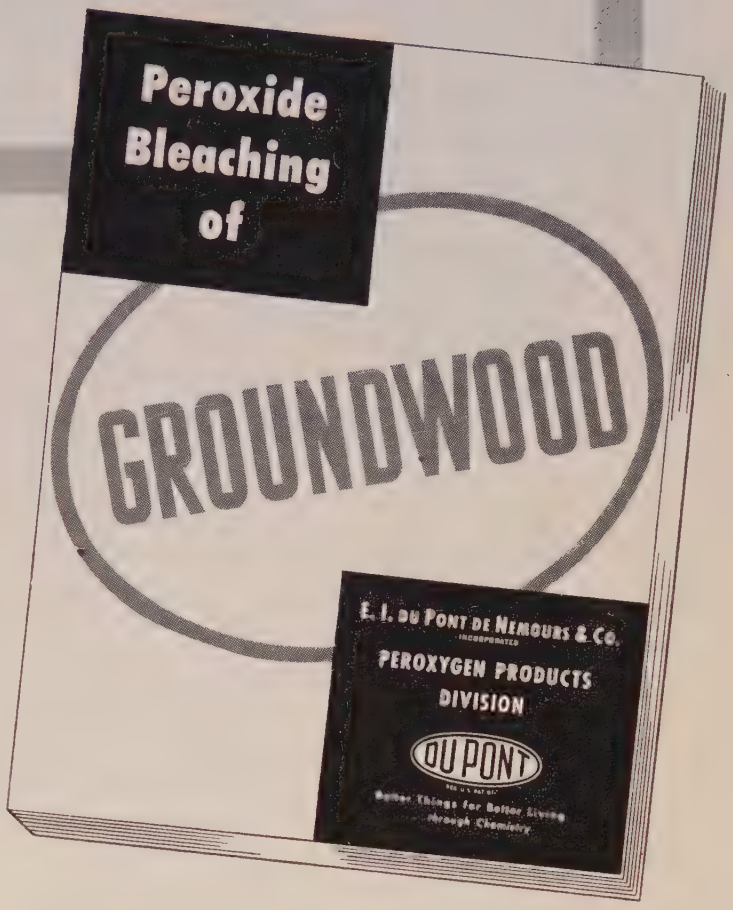

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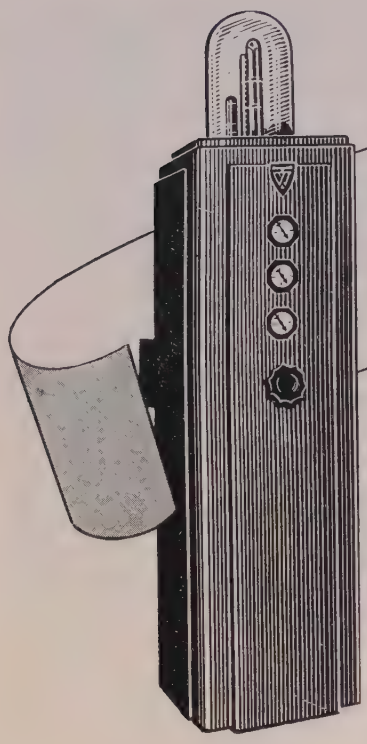

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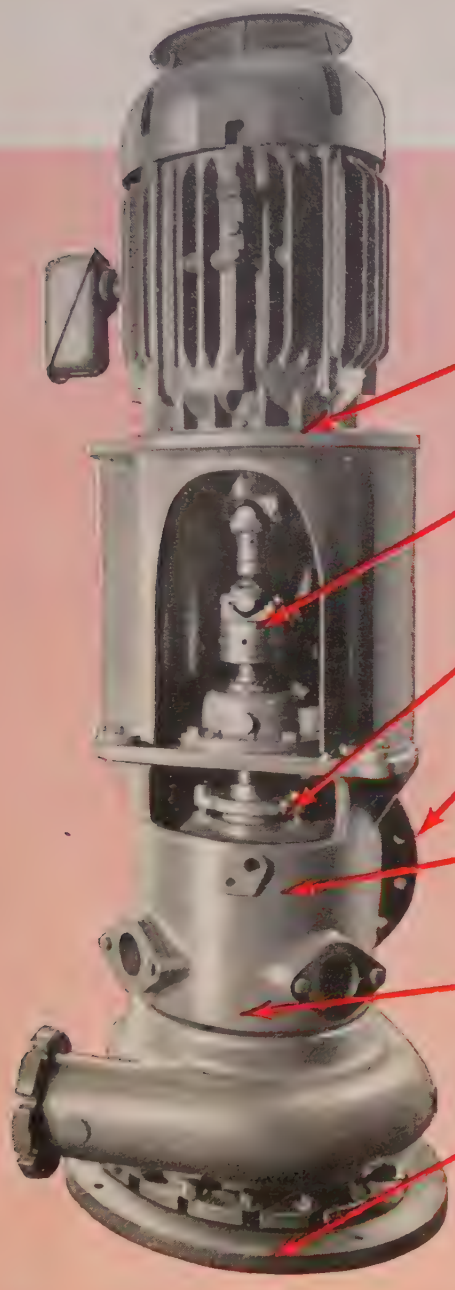

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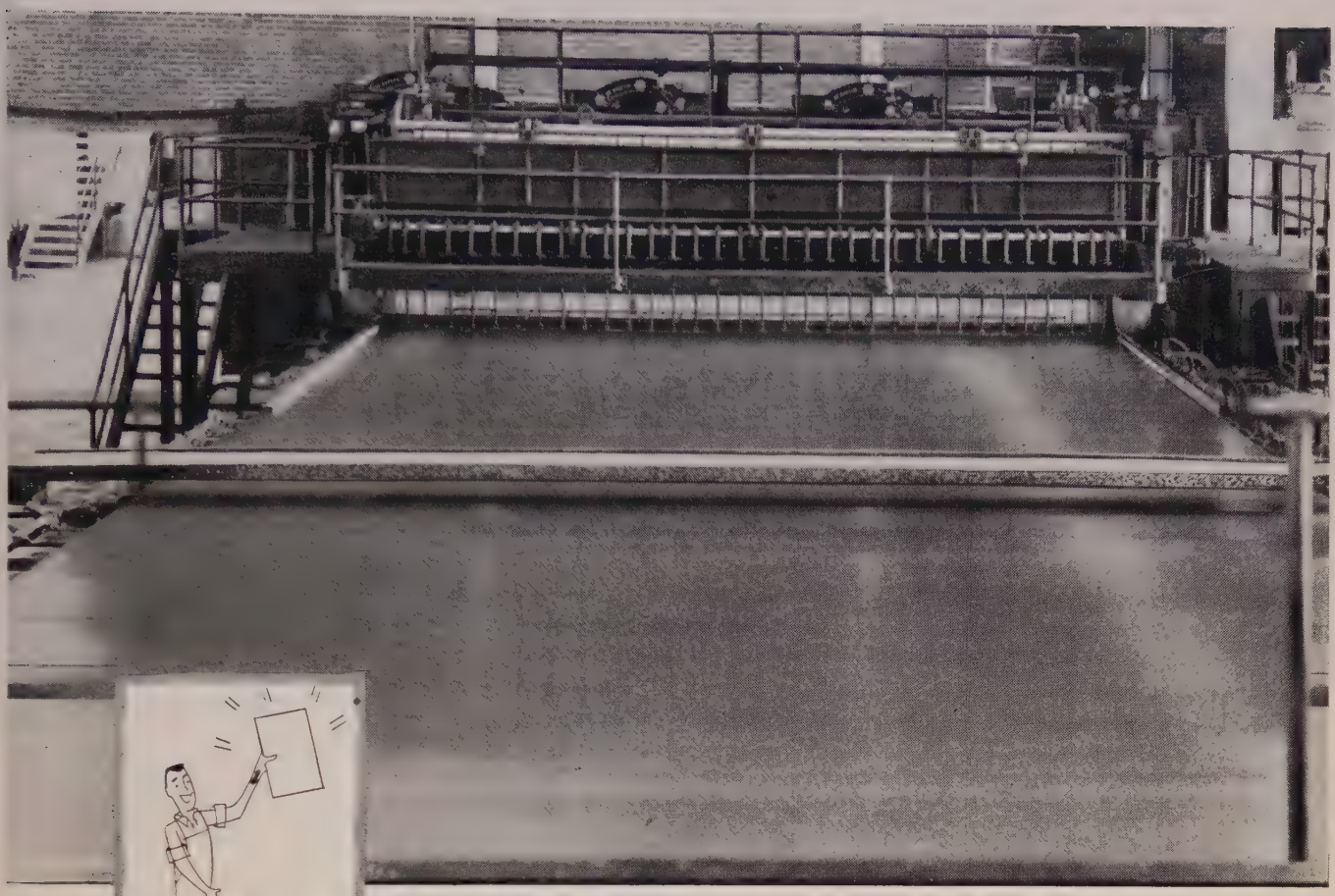

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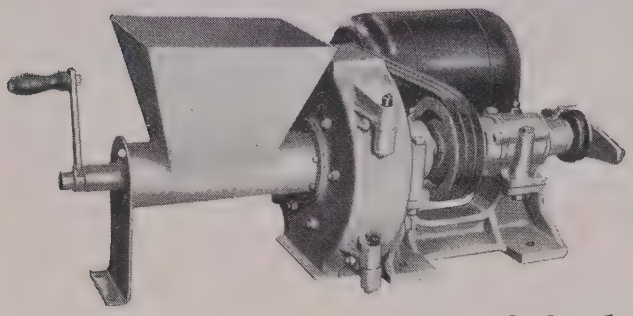

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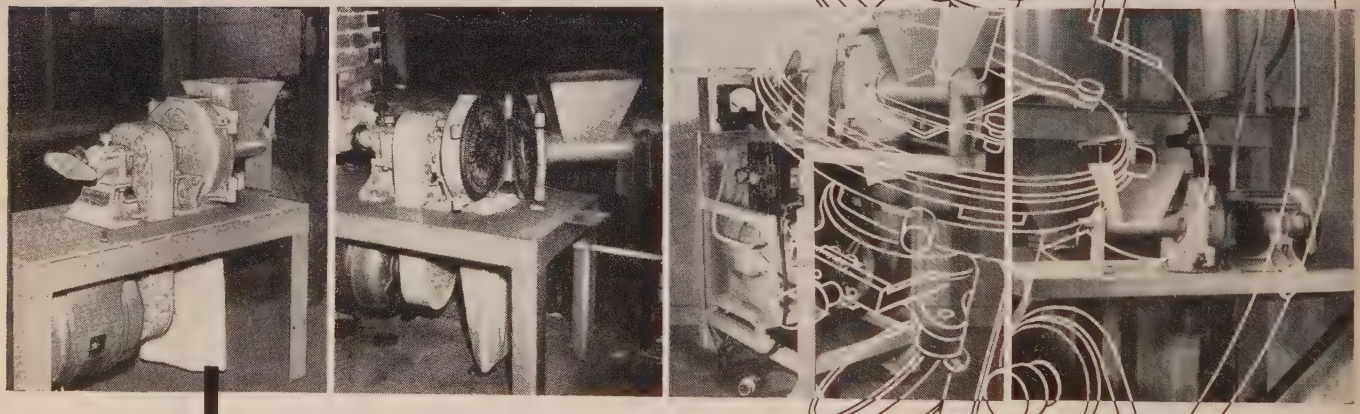

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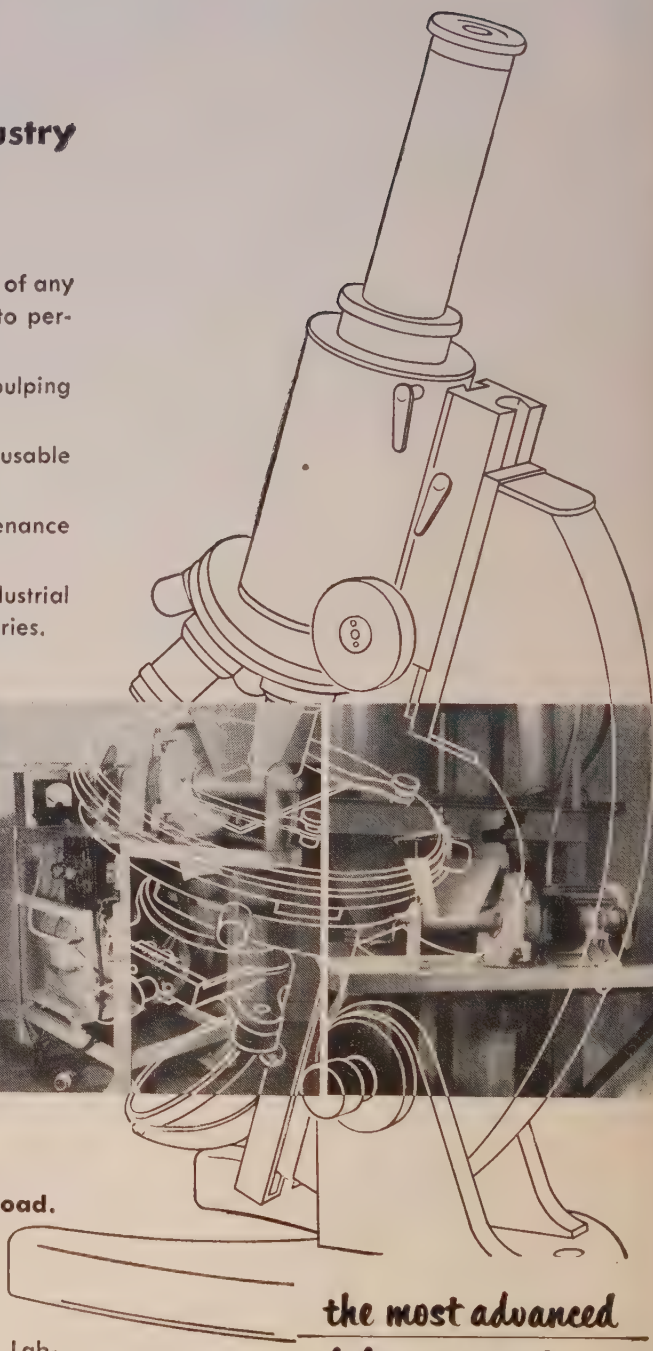

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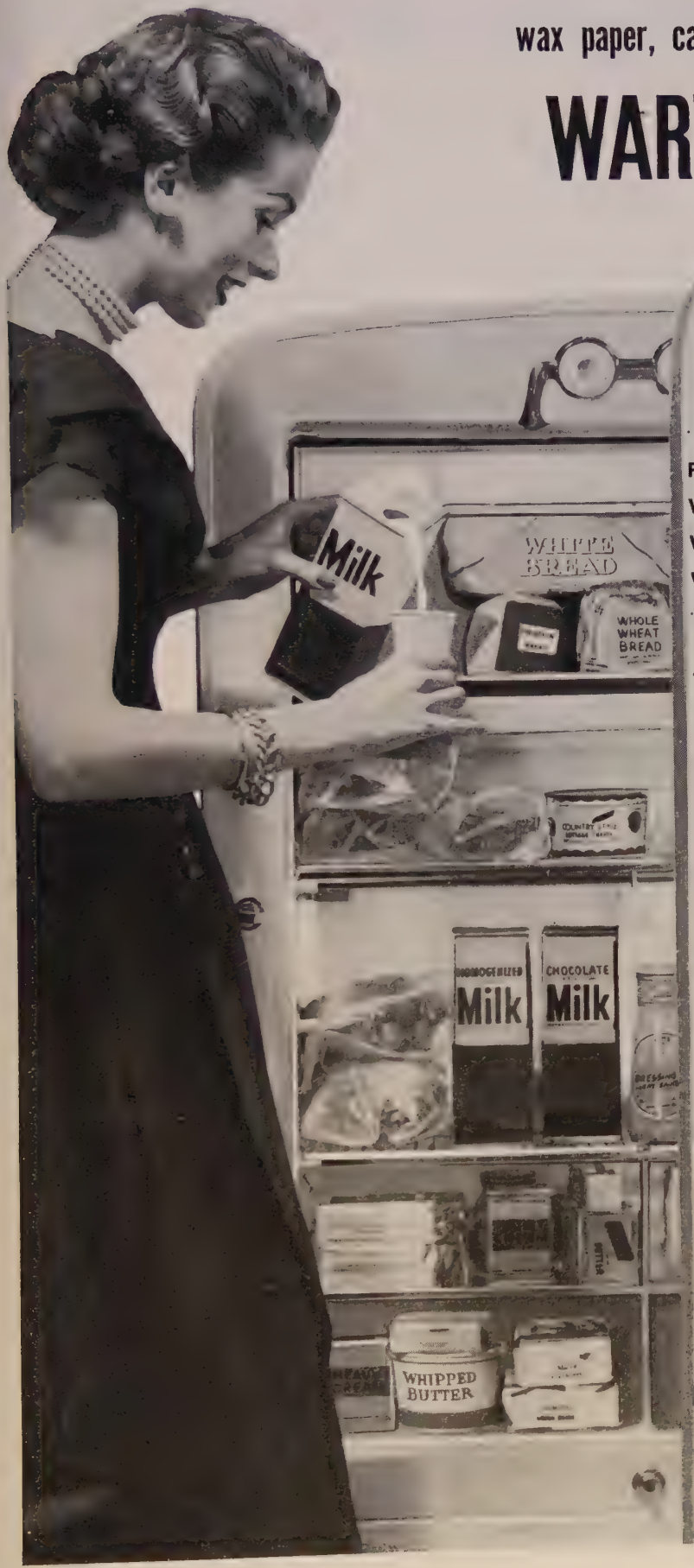

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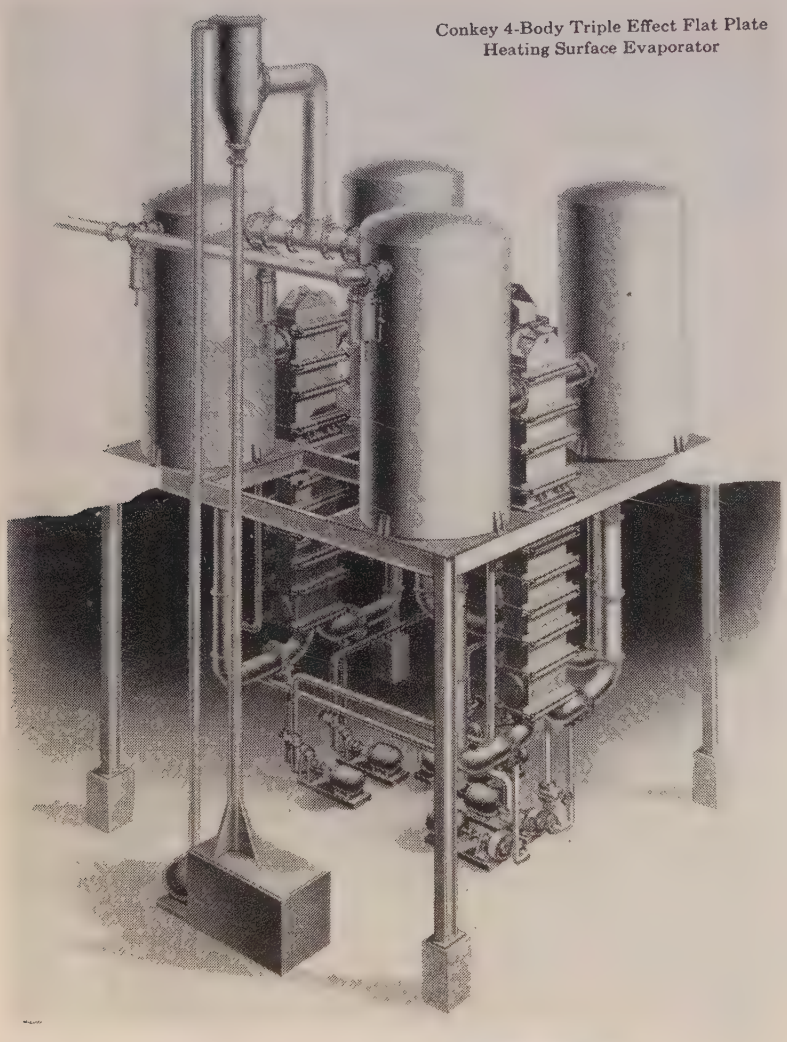

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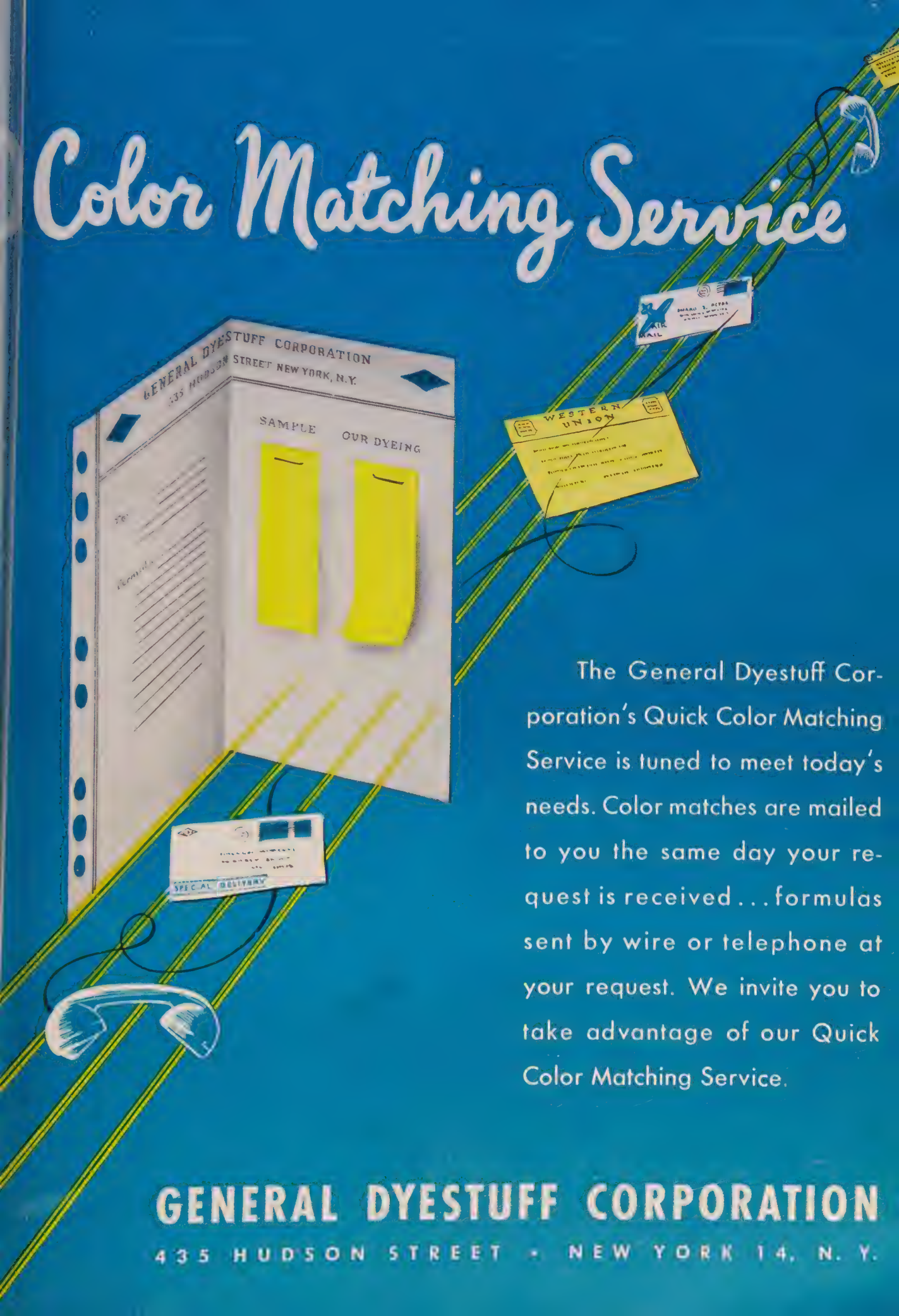

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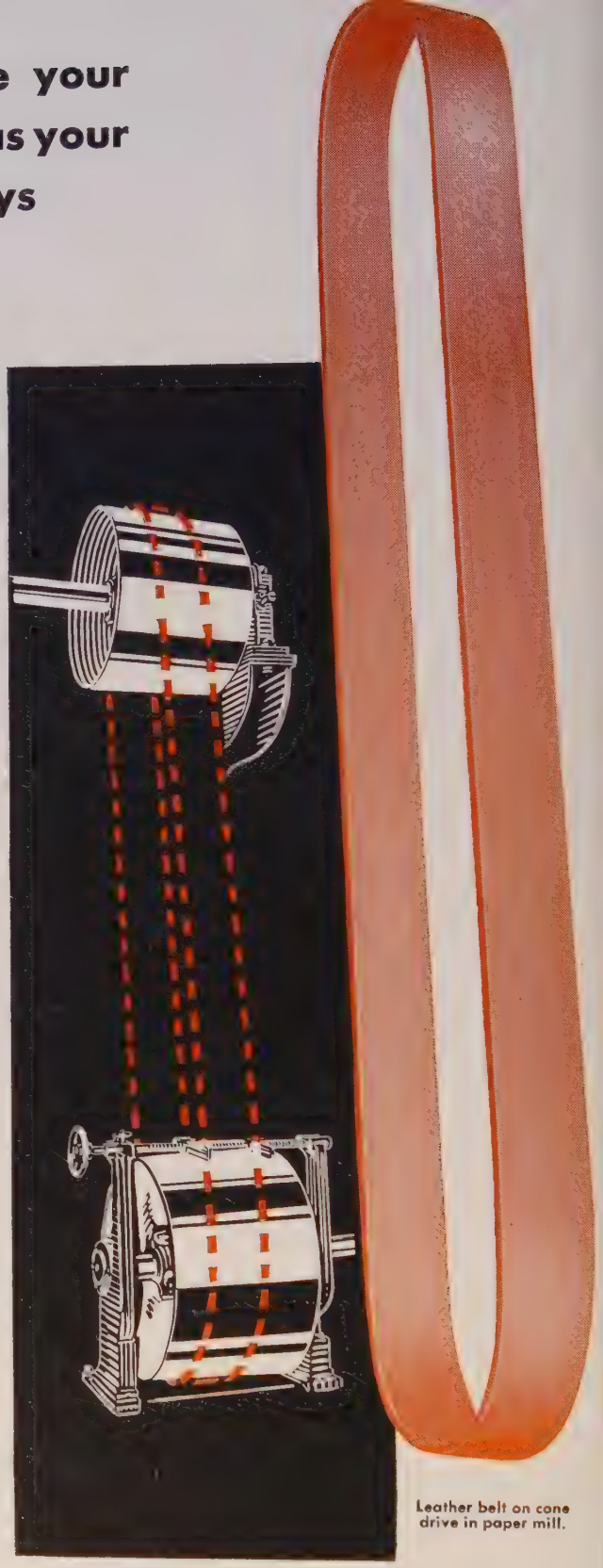

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Flow in "Converging Nozzle" Type Slices

Can Negative Pressure Be Present?

J. B. GOUGH

This analysis investigates the pressure of the flow against a straight converging top slice plate, in an approximate manner, for any orifice or jet velocity (particularly at 300 and 600 f.p.m.), any orifice or slice opening (particularly at 0.36, 0.375, and 0.72 in.), and any convergent angle (particularly at 50, 40, 30, 20, and 10°) of the inclined top slice plate in relation to the horizontal bottom apron plate. The results indicate that a negative pressure (i.e., below atmospheric pressure) will be present at this inclined top slice surface for a jet or approximate wire speed of 300 f.p.m., *if* in contact with the liquid (or pond) for any greater distance than 6 in. approx. (from the lip edge), when the angle of convergence is 50° (or more), or for any greater distance than 9 in. approx., when this angle is 30° (or more); thus a negative pressure will occur in a completely sealed nozzle (one having no pond or liquid-air surface), or in a sealed pond under a vacuum, if these critical lengths are exceeded. For speeds of 600 f.p.m. or more, no such negative pressure will be present, even at distances of 24 in. from the lip, unless the angle of convergence exceeds 50°, or unless a sealed pond is under a sufficient vacuum. However, with any liquid-air pond surface, it is possible that a negative pressure between the liquid and the surface of the inclined top slice plate will occur at and just below the point of intersection of pond and inclined plate surface, if the approach velocity of the pond surface is zero or very low. Two alternative methods of analysis are used, the first neglecting the effect of friction and the second taking it into account, approximately. The added effect of the curved flow which may be present, due to the usual hinge or curve in the top plate, which will lower these pressures still further, is also briefly discussed; also the possibility of air entrainment at any liquid-air surface, such as an open or closed pond, if this surface intersects the inclined surface of the top slice plate, and the surface velocity of approach is zero or very low, or if the pond surface intersects a curve or hinge in the top slice plate. The possibly bad effect of these negative pressures (and air entrainment) on the smoothness and uniformity of the jet from the slice orifice and on the resulting formation and sheet quality is also discussed.

THE oft-repeated phrase, and one very generally accepted by experienced papermakers, that "the sheet is made in the stock preparation department" is no doubt true, but it is obviously even more true that it can be unmade again, or its best possibilities lost and its quality greatly impaired by what happens to it in the flowbox and slice, as well as between the slice orifice and the first flat vacuum box, and even in the later stages on its way to the calender and reel, or to the supercalender, etc.

A great deal of thought, effort, and experimentation has been applied, especially in the last 20 years, to the design of the flowbox and slice and this has resulted in very definite improvements, particularly in raising the machine speed limit, but to a much less degree in improving the uniformity of basis weight and sheet formation.

As regards the slice and its orifice, except for providing more or less curved and converging tapered nozzles with local screw adjustments of the top lip to compensate for nonuniform flow to the nozzle, as well as an adjustment of the angle of nozzle convergence and the relative location and setting of the top and bottom lip to each other and in relation to the breast roll and wire, all of which improvements and adjustments have been shown to have a very definite effect on the sheet deposited on the wire and on the resulting finished sheet characteristics and quality, the effect of the conditions of flow, velocity, and pressure within the converging nozzle itself does not appear to have been given much study, except for the experiments of Bryant and Moss, (*1*) which experiments prove that the shape and design of the nozzle itself do have an effect on the resulting fiber orientation and therefore on the directional strength and other characteristics of the sheet laid on the wire.

The object of this present paper is to discuss an approximate analysis of the flow conditions within a converging nozzle, particularly the pressure between the liquid flow and the surface of the adjustable, straight inclined top slice plate, and how this pressure varies at various points along the surface of this top slice plate, or from orifice to pond surface, or to hinge, as the case may be, for various wire and jet velocities, orifice openings, and for different angles and lengths of top slice plate. If this pressure becomes negative (i.e., below A.T.P.) at any point on the surface of the top slice plate in contact with the liquid flow, as it certainly may with a closed pressure-type nozzle having no pond or liquid-air surface, or with a closed pond under appreciable vacuum, at somewhat low wire and jet velocities, large angles of convergence and long top slice plates, then air will be liberated from within any flow which is saturated with air in solution (at the prevailing temperature), and additional air will also be introduced into the nozzle flow, if this negative pressure occurs at a submerged hinge, unless this hinge is absolutely airtight.

If the nozzle is supplied from a pond having a liquid-air surface, either an open pond at atmospheric pressure, or a closed pond under positive or negative air pressure, then a slight negative (?) pressure will exist at the surface of the pond if it is in contact with the inclined straight top slice plate, and even more so if in contact with a curve or hinge, and air will be entrained at this point, even if there is no foam on the pond surface, if the pond surface does not have a positive velocity

J. B. GOUGH, Consultant, The Mead Corp., Chillicothe, Ohio.

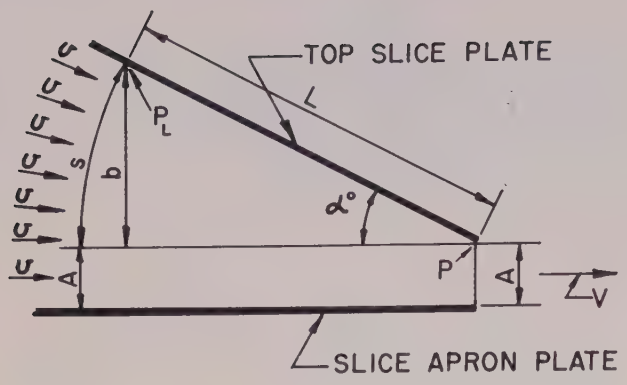

Fig. 1A

of approach toward the nozzle, and if this velocity is not sufficient to satisfy the conditions of flow, velocity, friction, etc., demanded by and existing in the adjacent nozzle.

APPROXIMATE ANALYSIS, NEGLECTING FRICTION

While a much more exact solution is possible, and one which includes the friction due to the viscosity of the flowing liquid and its friction against the solid surfaces of the nozzle, this first rough approximate analysis neglecting friction has the advantage of being simple in form and requiring very much less mathematical and arithmetical calculation, and the further advantage of providing some confirmation of the somewhat more exact analysis given later, in which latter friction has been allowed for, although only in an approximate manner.

This first solution is based on the well-known constant energy equation of Bernoulli, which, as far as it goes, is quite exact, although in this application the assumption that the velocity is constant over the arc $s + A$ is not correct because of friction and viscosity effects.

Figure 1A shows the general design and shape of the nozzles and gives the symbols of the various factors that affect the pressure of the liquid flow against the surface of the top slice plate.

The pressure of this flow, positive if above A.T.P. and negative if below A.T.P., in feet of water is:

$$\frac{1}{0.434}(P_L - P) = \frac{V^2}{64.4}\left\{1 - \frac{1}{\left(1 + \frac{\pi L \alpha^\circ}{180A}\right)^2}\right\} - L \sin \alpha^\circ \qquad (1)$$

The detailed solution of this first approximate equation (1) is given in the Appendix.

Figure 1B gives the difference in pressure, as feet of water, either above or below A.T.P., at the surface of the top slice plate, at various distances from the slice lip or orifice, for converging angles of 50, 40, 30, 20, and 10°, for an orifice (and wire?) velocity of 5 f.p.s. (300 f.p.m.) and a width of orifice of 0.03 ft. = (0.36 in.).

The "solid line" curves in Fig. 1B show that the pressure of the liquid flow against the surface of the top slice plate at first rises rather rapidly above the atmospheric pressure P at the orifice and then falls more slowly, as the distance L from the orifice increases, and becomes equal to the atmospheric pressure again when $L = 0.5$ ft. for $\alpha^\circ = 50°$, $L = 0.6$ ft. for $\alpha^\circ = 40°$, and $L = 0.775$ ft. for $\alpha^\circ = 30°$, etc., and becomes increasingly negative if the "wetted" length L is further increased. For angles of 20° or less the pressure of the flow against the top slice plate will not become negative for any usual length of straight top slice plate for $V = 5$ f.p.s., and $A = 0.03$ ft., or for any higher value of V, and is very unlikely to do so even if the orifice opening is increased to $A = 0.06$ ft., corresponding to a very heavy basis weight sheet and/or a very low consistency in the flow box; the "dotted line" portion of a curve for $A = 0.06$ ft. and $\alpha^\circ = 50$ and 20° is given to show the effect of increasing the orifice opening to 0.06 ft. at the critical length L beyond which the pressure becomes negative. It should be noted that with an open atmospheric pond, the length L at which this pressure changes from positive to negative should correspond exactly with the surface of the pond at the theoretical head corresponding to the jet velocity, since friction is ignored.

However, it is not safe to assume from the above results that there is no possibility of a negative pressure being present in a straight converging nozzle of the type shown in Fig. 1A with velocities V of 5 f.p.s., of more, even with an open pond and low values of L and α, because many such straight adjustable top slice plates also have a curved portion, and most of them are provided with an actual hinge of very small radius around which the liquid must flow to enter the orifice. This curved flow sets up centrifugal forces which also will reduce the liquid pressure against this curved portion, or hinge, and this effect increases directly as the "square" of the velocity and inversely as the radius of this curve. It is thus certain that the pressure of the liquid flow against the surface of the top slice plate as shown in Fig. 1A will be reduced below the values shown in 1B at the curved portion, if the curved portion is submerged, and may be sufficiently reduced to change an otherwise positive pressure into a negative pressure. The usually adjacent perforated roll may also reduce this pressure still further, especially if it is close and the jet velocities high.

MORE EXACT ANALYSIS, INCLUDING FRICTION

While not exact, the Chezy formula for the loss of pressure, or head, due to liquid flow in channels is quite generally accepted; this is also the case with Bazin's formula for the empirical coefficient C_1 in the

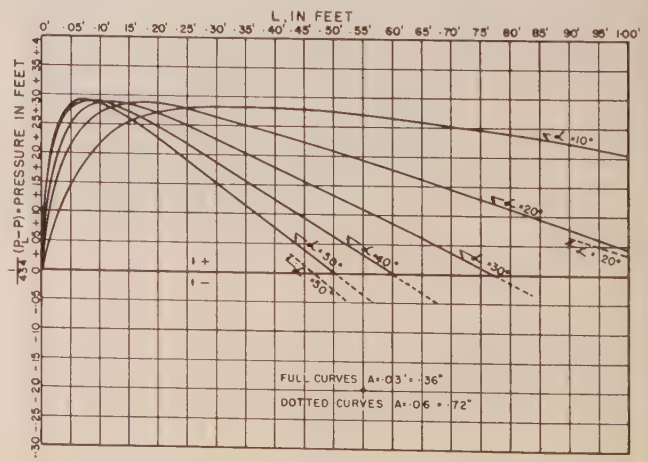

Fig. 1B

Chezy formula; these have been used in this analysis, and their form and use are given in the Appendix. Formulas are available that are probably more accurate, but they introduce additional difficulties and complications in the analysis and calculations that did not appear advisable, especially as the final results appear to indicate that the effect of friction has very little influence on the important point at which the pressure on the top slice plate changes from positive to negative.

Figure 2A shows the general design and shape of the nozzle and is very similar to Fig. 1A, except for a slight modification of the factors and their symbols required for this more accurate, as well as more complicated, analysis.

The pressure of the liquid flow against the surface of the top slice plate, positive if above A.T.P., and negative if below A.T.P., in feet of water, is:

$$\frac{1}{0.434}(P_L - P) = V^2 \left\{1 - \frac{1}{[1 + (L/A)\sin\alpha^\circ]^2}\right\} \times \left(\frac{1}{2g} + \frac{C}{\sin\alpha^\circ}\right) - \frac{A}{2} - L\sin\alpha^\circ \quad (2)$$

Where C is a modified coefficient of the friction of flow, derived from Bazin's coefficient C_1, and corrected for the varying "hydraulic mean depth" m in the Bazin formula, between $L = 0$ and $L = L$, thus providing an average m and an average C over the length L. The detailed derivation of equation (2), and also of C and m, is given in the Appendix. Figure 3 also gives the average values of C between $L = 0$ and $L = L$, as derived by the analysis given. As the usual flowbox consistencies are between about 0.35 and 1%, the friction effect has been assumed the same as for water.

Figure 2B gives the results of equation (2) for $V = 5$ and 10 f.p.s., and for angles of convergence of 50 and 30°, and for $V = 5$ f.p.s. it will be noted that there is little difference between the values of L in the equations (1) and (2) and Fig. 1B and 2B, for similar degrees of convergence, beyond which this pressure becomes negative, even though one of the determinations ignores friction and the other does not. Of course, there should be a slight difference due to the effect of friction, and the critical value of L from equation (2) and curve 2B should therefore be slightly greater than for the corresponding value of L obtained from the theoretical head required without friction

This rather close agreement between rather dissimilar methods of analysis would seem to indicate that the method of analysis is not too critical and that these

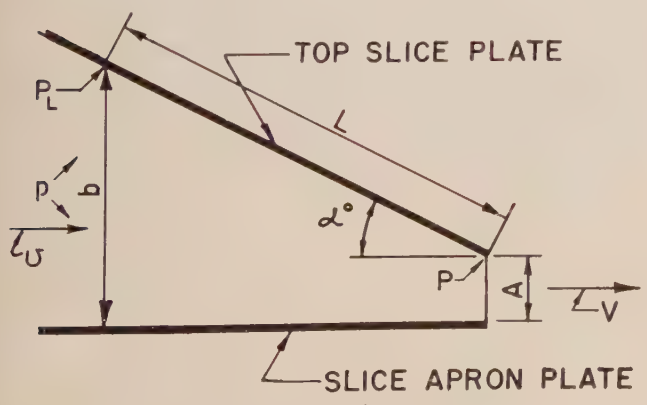

Fig. 2A

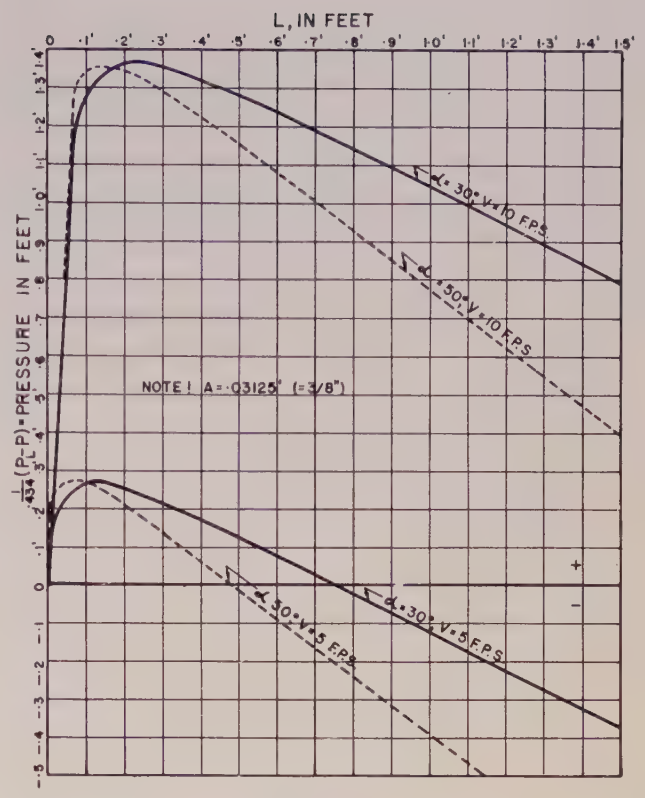

Fig. 2B

results are approximately correct. It also appears that the coefficient of friction, and the loss of pressure due to friction, during flow through the nozzle is a very minor item as regards the fluid pressure against the top slice plate, or on the value of L at which this pressure changes from positive to negative; this certainly appears to be the case even although some experienced operators have reported the necessity of repolishing both the top slice and the bottom apron plate after prolonged use in order to improve the delivery of the jet onto the wire.

THE ADDITIONAL REDUCTION IN PRESSURE DUE TO CURVED FLOW

If the top slice plate is curved, as was the original Van de Carr slice, then it is certain that the effect of centrifugal force will reduce the pressure on this inwardly curved surface below what it would have been otherwise, even if this radius is relatively large as it was on the above slice, which had no true hinge. Most modern slices do have a true hinge (like a door) and the radius is quite small, and the drop in pressure due to curved flow around this hinge must be relatively much greater, even at the same velocity, and this drop in pressure will increase twice as fast as the velocity is increased.

An attempt to solve the basic equation for curved flow,

$$\frac{dp}{dr} = \frac{wv^2}{gr}$$

was unsuccessful because of the difficulty of establishing a reliably correct relation between v and r in this particular case; and it would appear necessary to resort to conformal mapping, or the flow net, or the classic differential equations of hydrodynamics, in

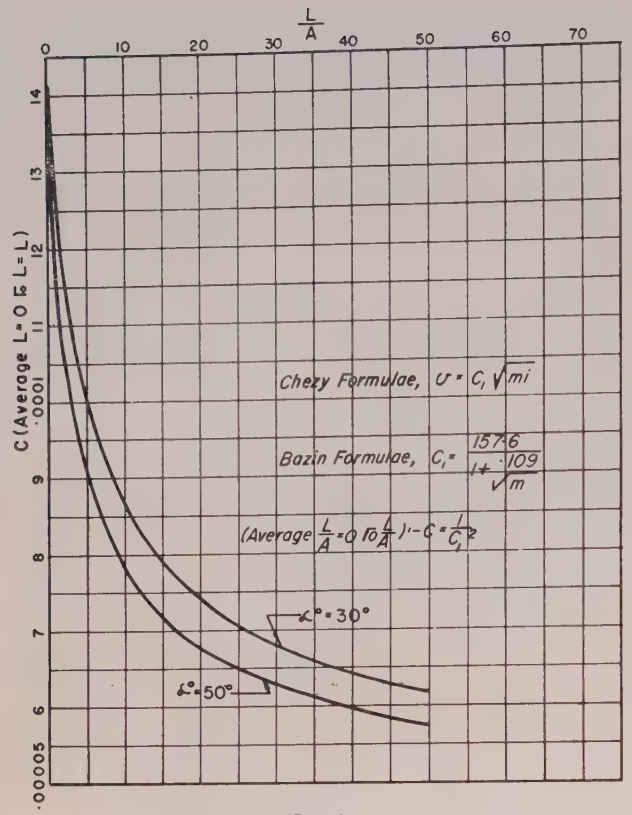

Fig. 3

order to solve more exactly this particular case of a hinged, convergent, straight top slice plate; especially so if the surface of the pond intersects either the straight or curved surface of the nozzle.

CONCLUSIONS

This type of straight convergent nozzle would appear to have a very real inherent ability (*2*) to reduce small eddies and turbulence present at its entrance (as well as to reduce flocculing) (*1*), and even change a turbulent flow from the flowbox into a "glasslike" laminar flow from the orifice, especially so if the angle of convergence $\alpha°$ is 15° or more and the orifice velocity V does not exceed, say, 10 f.p.s. However, for one reason or another, such a smooth and clear "glasslike" jet must be indeed a very rare occurrence, and it would seem that one or more of the following factors are preventing such a desirable jet being obtained, or even approached:

1. The flowbox design is so inefficient for the flow volume that there is extreme turbulence and very large eddies in the flow to the nozzle, which may not have time to die by the time the orifice is reached, especially if nozzle is short.

2. The perforated roll adjacent to the nozzle is too small in diameter, or in percentage hole area, or it is located too near the entrance to the nozzle, or its holes are too large, or the nozzle too short, and thus the relatively high velocities of the jets from the perforated roll and the eddies resulting from them do not have sufficient time to be dissipated before arriving at the orifice, even with the help of this strong damping effect of the rapidly converging nozzle. These high velocity jets from this perforated roll not only produce minor turbulence and eddies in the flow to the nozzle, but also cause a slight loss of pressure which may also result in air coming out of solution.

3. The extreme edge of the lip on the top slice (or the bottom apron) plate is not sharp and true, or may have been rounded off due to the use of a metal wire for cleaning this important edge, and the nozzle may have thus become divergent at the orifice, instead of convergent, and thus extremely unstable and thus produce the familiar ridges and valleys in the top surface of the jet; a top lip set too far ahead of the bottom lip would would give this same effect (except maybe in the case of pressure formation on the wire).

4. The inner surfaces of the nozzle have become rough, or pitted, as this has been found detrimental to a smooth jet.

5. Due to bubbles of air entrained in the flow to the nozzle rising to the surface of the top slice plate on account of curved flow and/or their relatively low density.

6. Air (or other gases) previously dissolved in the liquid coming out of solution and forming minute air bubbles, especially if the liquid is saturated with air in solution at A.T.P. (at the prevailing temperature), if negative pressure is present at the surface of the top slice plate, as per curves of Fig. 1B, or Fig. 2B, and/or due to curved flow around a small radius curve or hinge in the top slice plate.

7. Air leaking into the nozzle flow at the hinge, if it is submerged and not airtight, if the pressure at this hinge is negative due to curved flow and/or as shown in Figs. 1B or 2B.

8. If a negative pressure is present at any point on the surface of the top slice plate or hinge, and if it is sufficiently large, it will cause cavitation at this surface, especially if the liquid temperature is high, and even if no air is present as air bubbles or as air in solution, and the liquid flow in the nozzle will then become unstable and generate eddies, and may even separate from the surface of the top slice plate, all resulting in a jet from the orifice that will be unstable, rough, and irregular, and show the familiar ridges and valleys in its top surface.

9. If the nozzle is supplied from a pond having a liquid-air surface, either open or closed and sealed, and which approximately horizontal surface intersects the inclined surface of the top slice plate (or its hinge), then a slightly negative pressure will develop at this point of intersection, and air will be drawn into the flow (and maybe froth also) if the approach velocity at this pond surface is zero or not sufficient to establish the conditions of flow demanded in the nozzle itself.

Items 6, 7, 8, and 9 in the above list are, of course, the main factors discussed in this paper, although they are obviously by no means the only important ones or the only ones that can prevent a smooth and uniform jet from the slice orifice, and/or a uniform and desirable formation on the wire.

As regards item 7, this could be checked rather simply when starting up with only water in the flow box, after a shutdown and thorough wash-up, especially including the hinge itself. If the hinge does not leak water with a normal head of water in the pond and a normal slice opening, but does leak water when the slice opening is closed, or blocked shut on a length of rubber hose, then air will be leaking into the nozzle flow through the hinge

during regular operation, or at least until such air leaks at this hinge are plugged with fiber and/or slime.

Not only does the presence of air bubbles in the nozzle flow, particularly if they are between the liquid flow and the surface of the top slice plate as is most likely, definitely disturb the jet from the orifice and make it nonuniform, rough, irregular, and the top surface of the jet full of unstable and wandering ridges and valleys which persist for some distance down the wire and must result in nonuniform basis weight both crosswise and lengthwise of the sheet, as well as disturbing the formation and increasing the size and number of flocs, but also some of the smaller of these bubbles will be entrained in the liquid flow itself and thus will be present within the jet and within the formation deposited on the wire.

In addition to this, the existence of any even slight negative pressure within the liquid flow in the nozzle will result in the immediate formation of very minute air bubbles if the liquid is saturated with air in solution at atmospheric pressure and at the prevailing temperature. These latter very small bubbles are especially strong and stable and each will remain separate and suspended within the jet and on the wire, entrapped between or attached to the fibers, and few, if any, will rise to the sheet surface or burst until after the sheet is formed and arrives at the flat vacuum box, and a few may even remain after the wet presses.

The presence of such air bubbles in the sheet forming on the wire will result in slower drainage on the wire, as well as pinholes, less density, higher bulk, less fiber bonds and strength, and more stretch in the finished sheet, some or all of which may be undesirable.

LITERATURE CITED

1. Bryant, O., and Moss, L. A., *Paper Trade J.* (April 14, 1938).
2. Gibson, A. H., "Hydraulics and Its Applications," page 56, 1919.

APPENDIX

Approximate analysis, neglecting friction (Figs. 1A and 1B). *Note:* Foot, pound, second, degree units; except P_L and P (p.s.i.).

$$b = L \sin \alpha, \quad s = \frac{\pi L \alpha}{180}, \quad \frac{V}{v} = \frac{\pi L \alpha}{180A} + 1$$

$$h + \frac{p}{w} + \frac{v^2}{2g} = A \text{ constant} \quad \text{(Bernoulli's theorem)}$$

$$\therefore b + \frac{P_L}{\omega} + \frac{v^2}{2g} = \frac{P}{\omega} + \frac{V^2}{2g} \quad \text{(see Fig. 1A)}$$

$$\therefore \frac{1}{0.434}(P_L - P) = \frac{V^2}{2g}\left\{1 - \frac{1}{[1+(\pi L \alpha^\circ/180A)]^2}\right\} - L \sin \alpha^\circ \quad (1)$$

Approximate analysis, including friction (Figs. 2A and 2B). *Note:* Units as above.

If, in this more exact analysis, V = average velocity at orifice A, and v = average velocity at section b, and p = average pressure at b,

$$bv = AV \quad \text{and} \quad v = \frac{AV}{b}$$

also

$$b = A + L \sin \alpha \quad \text{and} \quad v = \frac{V}{1 + (L \sin \alpha / A)}$$

Then,

$$\frac{b}{2} + \frac{p}{\omega} + \frac{v^2}{2g} = \frac{A}{2} + \frac{P}{\omega} + \frac{V^2}{2g} + F$$

where F = loss due to friction or

$$\frac{p}{\omega} = \frac{A}{2} - \frac{b}{2} + \frac{V^2}{2g} - \frac{v^2}{2g} + \frac{P}{\omega} + F$$

or, after substituting for b and v

$$\frac{p}{\omega} = \frac{V^2}{2g}\left\{1 - \frac{1}{[1 + (L/A)\sin \alpha]^2}\right\} + \frac{P}{\omega} - \frac{L}{2} \sin \alpha + F$$

But,

$$p = \frac{P_L + P_L + \omega b}{2} = P_L + \frac{\omega}{2}(A + L \sin \alpha)$$

$$\therefore \frac{p}{\omega} = \frac{P_L}{\omega} + \frac{1}{2}(A + L \sin \alpha) = \frac{V^2}{2g}\left\{1 - \frac{1}{[1 + (L/A)\sin \alpha]^2}\right\} + \frac{P}{\omega} - \frac{L}{2} \sin \alpha + F$$

Finally,

$$\therefore \frac{1}{\omega}(P_L - P) = \frac{V^2}{2g}\left\{1 - \frac{1}{[1 + (L/A)\sin \alpha]^2}\right\} - \left(\frac{A}{2} + L \sin \alpha\right) + F$$

To find the value of F, the energy loss due to friction in the above equation, from the Chezy and Bazin equations for the loss of head due to friction of water in channels, etc; where:

$$v = C_1 \sqrt{mi} \quad \text{(Chezy)}$$

$$C_1 = \frac{157.6}{1 + (N/\sqrt{m})} = \text{(Bazin)} = \frac{157.6}{1 + (0.109/\sqrt{m})} \text{ approx.}$$

and

$$C = \frac{1}{C_1^2}$$

$$v^2 = C_1^2 mi = C_1^2 m \frac{h}{L}$$

$$\therefore \quad \text{the loss of head } h = \frac{p}{\omega} = \frac{Lv^2}{C_1^2 m} = \frac{CLv^2}{m}$$

"hydraulic mean radius" m = area ÷ welted perimeter

$$\therefore \quad m = \frac{b \times 1'}{2 \times 1'} = \frac{1}{2}(A + L \sin \alpha) \text{ at point } L \text{ (except near side plates)}$$

Let m = "average hydraulic mean radius" between $L = 0$ and $L = L$
Then:

$$mL = \frac{1}{2}\int_{L=0}^{L=L} (A + L \sin \alpha) = \frac{1}{2}\left[AL + \frac{L^2}{2} \sin \alpha\right]_{L=0}^{L=L} + \text{constant}$$

Since

$$mL = 0, \text{ when } L = 0, \quad \therefore \text{ constant} = 0$$

$$\therefore \quad m = \frac{A}{2} + (L/4) \sin \alpha^\circ$$

Average values of m, C_1 and C were calculated on this basis, between $L = 0$ and $L = L$, and the resulting values of C, as used in equation (2) are given in Fig. 3.

Therefore, the *total* head loss F due to friction, between $L = 0$ and $L = L$ is:

$$F = C \int \frac{v^2}{m} \cdot dL = C \int_{L=0}^{L=L} \left(\frac{V}{1 + (L/A)\sin \alpha}\right)^2 \times \left(\frac{2}{A + L \sin \alpha}\right)$$

$$\therefore \quad F = C \int \left\{ \frac{A^2V^2}{(A + L\sin\alpha)^2} \times \frac{2}{(A + L\sin\alpha)} \right\} = C \int_{L=0}^{L=L} \frac{2A^2V^2}{(A + L\sin\alpha)^3}$$

Finally,

$$F = \frac{CV^2}{\sin\alpha} \left\{ 1 - \frac{1}{[1 + (L/A)\sin\alpha]^2} \right\}$$

Substituting for F, as above:

$$\frac{1}{\omega}(P_L - P) = \frac{V^2}{2g} \left\{ 1 - \frac{1}{[1 + (L/A)\sin\alpha]^2} \right\} - \left(\frac{A}{2} + L\sin\alpha\right) + \frac{CV^2}{\sin\alpha} \left\{ 1 - \frac{1}{[1 + (L/A)\sin\alpha]^2} \right\}$$

$$\frac{1}{\omega}(P_L - P) = V^2 \left\{ 1 - \frac{1}{[1 + (L/A)\sin\alpha]^2} \right\} \left(\frac{1}{2g} + \frac{C}{\sin\alpha}\right) - \left(\frac{A}{2} + L\sin\alpha\right) \quad (2)$$

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Final Report—Press Section Load Requirements

R. R. BAKER

AT THE Fourth Engineering Conference of TAPPI held at Boston, Oct., 1949, Mr. Goodrich, Electrical Engineering Committee Chairman, presented the Committee Report on the "Recommended Power Constants" for various sections of the paper machine. This report covered both NRL (normal running load) and RDC (recommended drive capacity) constants for the principal sections of the paper machine, including the press section. This report appears in the Association's publication *Tappi* 33, No. 3: 113–117 (March, 1950). The findings of the committee were based on a study of reported load data on a large number of paper machine drives throughout the country, and no particular effort was made at the time to evaluate these constants with respect to either operating conditions or machine characteristics. Subsequent to the publication of this report the Engineering Division of TAPPI has issued Data Sheets identified as 145-G-H-I, dated Dec., 1951, which cover the committee's power constant recommendations.

At the Fifth Engineering Conference held at Cincinnati in 1950 the committee determined, among other things, to make a further study of the power requirements of the press sections including main presses, smoothing presses, breaker stacks, and dual press sections but not including presses operated on common felts. A preliminary report on the findings of this study was presented at the Sixth Engineering Conference in Savannah, and this report represents the final report of the subcommittee.

During the past year additional power readings have been obtained on certain of the sectional driven paper machines, a number of which were covered by the original survey. A total of 25 power readings were obtained from 25 different press sections, 19 of which represented check readings on the original power data. These 19 power readings checked the original readings quite closely and, therefore, these readings appear to substantiate the accuracy of the original data.

MAIN PRESS SECTION

In regard to the main press section of the paper machine it has been quite generally felt that the power requirements of this section are dependent on a large number of variables which include: (1) roll width; (2) operating speed; (3) applied nip pressure; (4) weight of sheet produced; (5) roll diameter; (6) roll covering: (a) thickness and (b) hardness; (7) (with suction-type rolls) vacuum in suction box; (8) type of press bearings (sleeve or antifriction); and (9) press felt: (a) length, (b) number of felt carrying rolls, and (c) felt tension.

In order to evaluate as many of these variables as possible to determine their effect on the press power constants, a questionnaire was prepared and submitted to mills operating sectionally electric driven cylinder and fourdrinier types of paper machines. This questionnaire established:

1. The characteristics of the section on which observations were being taken including the following characteristics: (a) press type, (b) roll diameter, (c) roll covering; thickness and hardness, (d) type of bearings, and (e) face width of roll.
2. The location of the press on the paper machine.
3. The operating load, applied nip pressure, and vacuum on suction type presses. These data were obtained when making various grades of paper as well as when operating with reduced nip pressure and with the top roll raised.

The press section power survey was quite comprehensive covering both cylinder and fourdrinier machines ranging in width from 72 to 259 in. and producing a range of paper products including:

1. Paper weights varying from 11.5 to 150 lb. per 3000 sq. ft. and including tissue, glassine, news, book, bond, kraft papers, as well as other grades.
2. Board weights varying from 33 to 90 lb. per 1000 sq. ft.
3. Pulp sheets weighing approximately 350 lb. per 3000 sq. ft.

Two hundred and sixty-two power test readings covering 108 different machine sections were obtained from some 53 electrically driven sectional paper machine drives throughout the country. Each of the test readings was accompanied by a description of the machine section and the applied operating conditions. Seventy-six of the 262 power test readings indicated, in addition to the type of press and the nip pressure, the

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thickness and plastometer reading of the press roll coverings.

The data collected indicated a wide variation in operating practice throughout the mills. The ranges of operating practice with regard to press design and press adjustments were as follows:

1. Nip pressure with paper formation: plain presses 85 to 270 lb. per linear in.; suction press—58 to 254 lb. per linear in.

2. Nip pressure with board formation: plain presses—179 to 230 lb. per linear in.; suction press—45 to 332 lb. per linear in.

3. Nip pressure with pulp sheet production: 225 to 860 lb. per linear in.

4. Suction box vacuum on suction type presses: 8 to 25 in.

5. Roll diameter varying from a minimum of 18 in. diameter with 72-in. face on narrow board machines to 36 in. diameter with 250-in. face on wide paper forming machines, and to 40 in. diameter with 156-in. face on high nip pressure pulp sheet machines.

In order to properly correlate the main press section power data a tabulation was made of all of the power readings applying to this section of the machines. In tabulating the data each machine section on which power test data were obtained was identified by a different number, and in cases where a number of test readings were reported for the same section, each reading was identified by the section number together with an identifying subletter.

In order to make a critical study of the power data, the following classification was made of the main press section data:

I Paper weights—plain press (11.5 to 150 lb. per 3000 sq. ft.)
II Paper weights—suction press
III Board weights—plain press (33 to 90 lb. per 1000 sq. ft.)
IV Board weights—suction press
V Pulp sheets—plain press

The data were tabulated indicating: (1) test reading identification, (2) power data classification, (3) where suction type presses were used, the operating roll vacuum was indicated, (4) power requirements (hp. per in. per 100 f.p.m.), and as there appeared to be a general relation between power requirements and applied nip pressure, the data were further classified as follows: test readings with the following nip pressure adjustments: 0, 0–100, 101–150, 151–200, 201–250, 251–300, 300 lb. and over.

These main press test data were recorded in a seven-page tabulation entitled "Power Requirements of Press Section" which was appended to and formed a a part of the preliminary report, but which is not being included in this final report.

The following average, minimum, and maximum readings occur for the various applied nip pressure classifications:

Applied nip pressure, lb. per linear in.	*Power readings*			
	No.	*Av.*	*Min.*	*Max.*
0	14	0.0055	0.0018	0.0123
1–100	47	0.0123	0.0058	0.0290
101–150	52	0.0158	0.0081	0.0306
151–200	32	0.0178	0.0123	0.0364
201–250	12	0.0178	0.0107	0.0410
251–300	12	0.0210	0.0152	0.0360
301 and over	6	0.0327	0.0172	0.0587

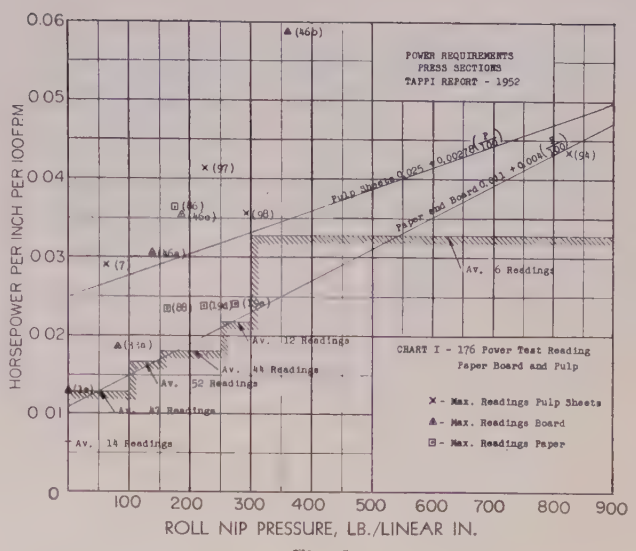

Fig. 1

Figure 1 shows the relation between the press power requirements and the roll nip pressure. On this chart the average power requirements have been blocked in over the range of nip pressures applied. On this same figure two lines, one represented by the equation:

$$\text{hp./in./100 f.p.m.} = 0.011 + 0.004\left(\frac{P}{100}\right) \qquad (1)$$

and one represented by the equation:

$$\text{hp./in./100 f.p.m.} = 0.017 + 0.006\left(\frac{P}{100}\right) \qquad (2)$$

have been shown. The line represented by equation (1) appears to coincide quite closely with the average power requirements. On this same chart the maximum readings have been "spotted-in" and identified.

Two tabulations were prepared, one covering "maximum readings" and one covering "minimum readings" which serve to identify the operating conditions applying to these points of extreme variation from average performance. These two tabulations are included with the final report as Tables I and II.

In connection with the power requirement curve as covered by equation (1), it will be noted that less than 13% of all test readings exceed the curve values by more than 20%. It also appears from the power test readings that the vacuum applied to the roll suction boxes on the suction-type press has little effect on the actual power requirements. This is undoubtedly due to the fact that sealing strips are used in the suction box designs, and therefore the boxes can be sealed off and still provide the necessary clearance between the box and the inner surface of the roll shell to prevent binding. Checking some 67 test readings with the vacuum varying from 8 to 25 in. with applied nip pressures ranging from 58 to 300 lb. per linear in. and with the paper machines in normal production, definitely indicated that there was no significant relation between roll vacuum and the power requirements.

From the 76 load readings in which the type, thickness, and hardness of the press roll coverings were reported in addition to the operating nip pressure, it was observed that there was little, if any, coordination between press load and the hardness of the roll covering. These 76 test readings were classified into four groups namely:

Table I. Minimum Test Readings

Identification		Machine		Press			Power constant Nip		Top roll			Bottom roll			Press felt			Press bearings, anti-friction or sleeve
Indent. No.	Class	Width, in.	Type, cyl. or fourd.	Position	Type, plain or suction	Box width, in.	Vacuum, in.	Hp./in./ 100 sq. ft.	pressure, p.s.i.	Diameter, in.	Weight, lb.	Covering	Thickness, in.	Plastometer	Diameter, in.	Covering	Thickness, in.	Plastometer	Length, ft.	Carrying rolls	Flat box or felt cond.	
33e	III	131	C	3rd	P	...	..	0.0018	0	22	7,000	Stonite	3/4	...	22	Rubber	3/4	25/30	56	10	FC	AF
44	II	221	F	1st	S	4	8	0.0058	58	28	9,370	Rubber	1.2	162/168	31	Rubber	1.2	30/35	55	6	ND	AF
62c	II	244	F	2nd	S	4	18	0.0081	119	28	15,300	Brass RC	1.5	45	34	Brass	..		60	ND	FC	AF
58b	I	123	F	2nd	P	...	..	0.0123	158	24	8,500	Stonite	...	...	24	Rubber	1	45/50	45	ND	ND	AF
82c	II	212	F	2nd	S	4	17	0.0107	230	28	15,000	CI-RC	1	45/50	32	Bronze RC	1	45/50	61	ND	FC	AF
106a	I	116	F	2nd	P	...	..	0.0152	270	20	7,000	Brass—chrom. plated	...	...	19	Rubber	3/8	18	43	ND	ND	AF
106b	I	116	F	2nd	P	...	..	0.0172	670	20	7,000	Brass—chrom. plated	...	...	19	Rubber	3/8	18	43	ND	ND	AF

ND—No data.

Table II. Maximum Test Readings

Identification		Machine		Press			Power constant Nip		Top roll			Bottom roll			Press felt			Press bearings, anti-friction or sleeve
Indent. No.	Class	Width, in.	Type, cyl. or fourd.	Position	Type, plain or suction	Box width, in.	Vacuum, in.	Hp./in./ 100 sq. ft.	pressure, p.s.i.	Diameter in.	Weight, lb.	Covering	Thickness, in.	Plastometer	Diameter, in.	Covering	Thickness, in.	Plastometer	Length, ft.	Carrying rolls	Flat box or felt cond.	
1e	III	72	C	2nd	P	...	...	0.0123	0	18	3,200	Brass	..	...	20	Rubber	1	32.5	42	10	FC	SL
7	V	170	C	2nd	P	...	...	0.0290	60	28	10,000	Bl. rubber	1	33	28	Rubber	1	36	55	6	ND	AF
33a	III	131	C	3rd	P	...	...	0.0187	82	22	7,000	Stonite	3/4	...	22	Rubber	3/4	25/30	56	10	FC	AF
46a	IV	124	C	2nd	S	ND	15	0.0306	138	22	8,680	Bronze	..	...	24.2	Rubber	1	25/30	90	13	ND	AF
46c	IV	124	C	2nd	S	ND	15.4	0.0352	189	22	8,680	Bronze	..	...	24.2	Rubber	1	25/30	90	13	ND	AF
86	II	163	F	1st	S	4.5	12	0.0364	185	26	11,900	Stonite	1	40/45	32	Rubber	1	31/33	62	ND	ND	AF
88	II	234	F	1st	S	5	14	0.0236	160	30.5	27,000	Stonite	1	40/45	34	Rubber	1	40/45	60	ND	ND	AF
19e	II	162	F	1st	S	4	18.5	0.0238	224	30	12,000	Rubber	1/2	35	30	Rubber	1/2	32.5	52	5	ND	AF
97	V	148	F	1st	S	4	8	0.0410	225	26	12,000	Rubber	1	25	30	Bronze RC	1	25	45	ND	ND	AF
19d	II	162	F	1st	S	4	18.5	0.0238	263	30	12,000	Rubber	1/2	35	30	Rubber	1/2	32.5	52	5	ND	AF
98	V	148	F	2nd	S	4	10	0.0360	260	26	12,000	Rubber	1	25	30	Bronze RC	1	25	45	ND	ND	AF
2a	IV	84	C	2nd	S	3	16	0.0227	332	18	3,500	Brass	..	...	20	Rubber	1	32.5	36	9	FC	AF
46b	IV	124	C	2nd	S	ND	16.6	0.0587	362	22	8,680	Bronze	..	...	24.2	Rubber	1	25/30	90	13	ND	AF
94	V	156	F	3rd	P	...	..	0.0122	823	40	35,000	Gun-metal	..	...	40	Rubber	1	30/35	63	ND	ND	AF
105b	I	116	F	1st	P	...	..	0.0190	670	20	6,350	Stonite	..	...	19.5	Rubber	3/	18/20	43	ND	FC	AF

ND—No data.

I Plain presses operating on paper weights

II Suction presses operating on paper weights

III Plain presses operating on board weights

IV Suction presses operating on board weights

It should be noted that the operating characteristics varied as follows within these four classifications.

Plain Presses Operating on Paper Weights—Classification I

Top Rolls:

Construction—brass, brass chrome plated, stonite, red stonite, hard rubber, granite and rubber covered, with $1^1/_8$-in. thick covering, plastometer reading 45.

Bottom Rolls:

$^3/_8$ to $1^1/_2$-in. rubber covered. Plastometer reading range 30 to 65. Nip pressure range 85 to 270 lb. per in. face.

Suction Presses Operating on Paper Weights—Classification II

Top Rolls:

Construction—granite, stonite, bronze, brass, hard rubber. Rubber covering range from $^1/_2$ to $1^1/_4$ in. thick. Plastometer range 30 to 168.

Bottom Rolls:

Rubber covering range $^1/_2$ to $1^1/_2$ in. thick. Plastometer range 15 to 50. Nip pressure range 58 to 254 lb. per in. face.

Plain Presses Operating on Board Weights—Classification III

Top Rolls:

Construction—brass, stonite, $^1/_2$-in. Rubroc Buna S, $^3/_4$-in. stonite, $^3/_4$-in. Rubroc plastometer 25, bronze.

Bottom Rolls:

1 in. rubber covered. Plastometer range $12^1/_2$ to 60. Nip pressure range 179 to 230 lb. per in. face.

Suction Presses Operating on Board Weights—Classification IV

Top Rolls:

Construction—brass, stonite, bronze, 1 to $1^1/_2$-in. rubber covering. Plastometer range $12^1/_2$ to 60.

Bottom Rolls:

Bronze, brass, 1-in. rubber covering. Plastometer range $12^1/_2$ to 60. Nip pressure range 45 to 332 lb. per in. face.

A study of Tables I and II giving the maximum and minimum power readings indicates quite clearly that there is little, if any, relationship between plastometer readings and operating power requirements. From these tables it will be noted that minimum power readings with plastometer readings ranging from 18 to 50 and maximum power readings with plastometer readings ranging from 25 to 45 are shown.

Machine	Machine width, in.	Description: Roll	Description: Diameter, in.	Description: Type	Hp./in./100 f.p.m.: Each roll	Hp./in./100 f.p.m.: Total
18a	102	1st	26	RC suction	0.0110	0.0220
		2nd	24	RC plain	0.0110	....
		Center	34	Granite	....	....
56a	175	1st	26	RC suction	0.0072	0.0259
		2nd	26	RC plain	0.0187	....
		Center	32	Stonite	....	....
65a	234	1st	32	Suction	0.0131	0.0262
		2nd	26	Plain	0.0131	....
		Center	42	.....	....	....
73a	234	1st	30	Suction	0.0115	0.0235
		2nd	30	Plain	0.0120	....
		Center	36	.....	....	....
Average per roll					0.0122	
Average pair rolls						0.0244

These power data would indicate that the general conclusions—that there is little, if any, relationship between power requirements and plastometer readings—are substantiated over a range of plastometer readings from 18 to 168.

So far as could be determined there appeared to be no significant relation between the press section power requirements and other operating variables, with these variables held within the range of operating practice as reported. The operating variables referred to include: (1) weight of sheet produced, (2) roll diameter, (3) type of press bearings, and (4) press felt length and number of carrying rolls.

Main Press Section Power Recommendations

The original committee recommendations which appear on TAPPI Data Sheet 145-G indicate the following:

Main press section, plain or suction type	Recommended constants, hp./in. width/100 f.p.m.: NRL	RDC
Pair main rolls	0.0225	0.030
Top roll only	....	0.010

In regard to the press operating constants the following note appears under Remarks: "Based on a maximum nip pressure of 175 lb. per in. width."

After reviewing the power data obtained as a result of this survey, it is recommended that the power constants for the main press section of cylinder of fourdrinier machines be modified as follows:

Main press section, plain or suction type	Recommended constants, hp./in. width/100 f.p.m.: NRL	RDC
Pair main rolls (all paper and board weights)	$0.011 + 0.004\ (P/100)$	0.030
Top roll only	..	0.010
Pair main rolls (pulp sheets)	$0.025 + 0.00278\ (P/100)$	0.045
Top roll only		0.015

Also Note (1) as applied to the main press section should be modified to read:

The recommended power constants for the main press rolls are based on: (1) A maximum nip pressure not exceeding 300 lb. per in. for all paper and board weight formations. (2) A maximum nip pressure not exceeding 900 lb. per linear in. for pulp sheet formation.

SMOOTHING PRESS

In addition to the power data on the main press sections this survey also included 19 test readings on smoothing press sections. These 19 readings covered a range of operating practice as follows:

Nip pressure, lb./linear in.	
Paper weights	70 to 115
Board weights	70 to 190
Paper weights, lb./3000 sq. ft.	32 to 70
Board weights, lb./1000 sq. ft.	33 to 90

The power requirements of the smoothing press as determined by the 19 test readings were as follows:

	Paper	Board
Number of readings	11	8
	Hp./in./100 f.p.m.	
Average	0.0054	0.0069
Maximum	0.0147	0.0124
Minimum	0.0026	0.0039

The original committee recommendations for smoothing press power constants are as follows:

	NRL	RDC
Pair rolls	0.0090	0.012

In view of the 19 test readings it is recommended that the NRL constant for the smoothing press section be reduced to 0.0070, and that the RDC constant of 0.0120 be retained. A note should be added that the constants are applicable for nip pressures not exceeding 190 lb. per linear in.

SIZE PRESS

This survey also included nine test readings on size press sections which covered the following ranges in operating practice:

Nip pressure, lb./linear in.	0 to 75
Paper weights, lb./3000 sq. ft.	30 to 70

From these nine readings the following power requirements were determined:

	Hp./in./100 f.p.m.
Average	0.0108
Maximum	0.0157
Minimum	0.0044

The original committee recommendations for the size press were as follows with nip pressure limited to 175 lb. pressure:

	NRL	RDC
Pair rolls	0.015	0.025

The nine additional readings obtained from the recent survey although suggesting a possible reduction in

both NRL and RDC constants, are not considered of a broad enough coverage to justify a change in the original recommendations. The survey also indicates that the present nip pressure limitation of 175 lb. per linear in. is adequate to cover the operating requirements.

DUAL PRESS

The survey only included eight test readings from four machines on side rolls of the dual press section. The original committee recommendations for this section were as follows:

	NRL	*RDC*
Dual press side rolls, each	0.0200	0.025

The survey indicated the following:

The very limited amount of data on dual press sections obtained from the survey do not justify any change in the original committee recommendations although the survey does indicate that the original recommendations should be checked further, and if future power data conform with that obtained recently, the constants should be reduced

The collection of the power data for this report required considerable time and effort on the part of a number of individuals. Many of these individuals were connected with the mills from which the data were obtained. The writer wishes to take this opportunity to acknowledge this extremely valuable assistance and to thank both the members of the mill organizations, as well as members of the Westinghouse Electric Corp. who were of great assistance in circulating the questionnaries and collecting the field data.

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Ozone Purification of Water

VICTOR HANN

Advances in ozone technology and new commercial availability of large-size ozone generators have combined to spur research in industrial ozone applications. An extremely powerful oxidant, unique in that it consists only of oxygen in active form, ozone is finding many new uses in chemical oxidations, in water purification, and in the treatment of industrial wastes. Ozone decomposes to ordinary oxygen in storage and therefore must be generated by the ultimate user at his own plant. Air or oxygen is compressed, dried, and passed through a special type of electrical discharge to form ozone. Ozone has long been used as a germicide in drinking water, particularly in Europe. Recent developments have shown it to be an extremely effective means of removing tastes, odors, and color from water. As a result, large ozone plants to improve water quality have been installed in the municipal water systems of Philadelphia, Paris, and other cities. A new ozone process for the destruction of phenols in industrial wastes appears to be the most efficient and economical means yet devised for reduction of phenol concentrations to the very low values required by governmental stream standards. In other industrial waste applications ozone is being used for oxidation of mercaptans in liquid wastes and for treatment of sewage gases to prevent atmospheric odor nuisance.

Although one of the most powerful of oxidants, ozone has long been a laboratory Cinderella whose less-favored sisters have taken her place at the ball. Known to chemists for more than 100 years, ozone up to now has failed to achieve the industrial importance and utility which would be the reasonable expectations for so unique a chemical. But recently, advances in ozone technology and, even more important, new commercial availability of efficient, dependable generators to produce ozone *in quantity*, have combined to put both slippers on Cinderella and to send her forth to a happy and useful industrial life.

Ozone is primarily a powerful oxidizing agent, exceeding all ordinary chemicals except fluorine in its oxidation potential. It is unique in that it consists only of oxygen. Ozone is a faintly blue, pungent-smelling gas. It is an allotropic form of oxygen in which three atoms of oxygen, instead of two as in the case of ordinary oxygen, are combined to form a molecule.

The ability of ozone easily to oxidize many materials, organic and inorganic, under conditions of ordinary temperature, pressure, and dilution is what makes it useful in a wide range of chemical oxidations including bleaching, in problems of water purification, and in industrial waste treatment.

Ozone is very unstable; it decomposes in a relatively short time. This, together with the fact that it is produced most economically in concentrations of only 1 or 2%, makes it decidedly impractical to store or to ship in containers. Although ozone can be liquefied and then concentrated in liquid form, this greatly increases its cost, and liquid ozone is dangerously explosive.

For these reasons ozone is always produced in gaseous form as needed, and at the point of use. Air or oxygen is dried and passed through a special type of electrical discharge which converts part of the oxygen into ozone. This mixture of air or oxygen plus 1 or 2% ozone is what is generally referred to simply as "ozone." The machine in which the special form of electric discharge takes place is called an "ozonator" or "ozonizer."

The figures presented will give an idea what a large ozone plant for water treatment looks like. These pictures are of the Belmont Ozone Plant of the City of Philadelphia. Figure 1 is a view of the building which houses the ozone generating equipment. The "raw materials" for ozone production are air and electricity. Electricity is brought to the main transformer bank at the left end of the building at 13,200 volts where it is stepped down to 460 volts, the operating and control voltage. Air is drawn into the building through the small square opening in the brickwork to the right of the transformer enclosure.

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Air passes through a combination electrostatic and paper filter which removes dirt and dust. Figure 2 shows a group of five rotary blowers which draw the air into the building and compress it to the 9 or 10 lb. pressure necessary to force the air through the subsequent coolers, driers, ozonators, and the 18-ft. head of water in the ozone–water mixing basins. The rotary compressors are noninternally lubricated since oil vapor would permanently impair the water-adsorptive capacity of the driers which follow. Because of fluctuating pollution conditions several blowers are provided to allow flexibility of operation. Also, in accordance with general water works practice, standby capacity is provided in blowers and in all other essential components of the plant.

The compressed air is next forced through one of the duplicate cooling units. The air passes first through water coils and then through Freon coils. The temperature of the air is reduced from about 200° to 40°F. This cooling serves to condense and remove the bulk of the moisture during the warmer months and the lower temperature also enhances the efficiency of the driers which follow.

In Fig. 3, the duplicate dual-tower driers are shown. Each drier has a pair of cells containing activated alumina desiccant; one such cell is placed on stream while the desiccant in the second is regenerated by forcing hot air through it. Process air enters the drier at about 40°F. and saturated with water vapor. The desiccant removes almost all of this moisture from the air; the leaving air contains only 0.01 to 0.02 grains of moisture per cu. ft. Air of this dryness is necessary for maximum efficiency of operation with ozonators of the Welsbach design.

The dried air then passes to the bank of 50 Welsbach ozonators shown in Fig. 4. Each ozonator has a nominal ozone producing capacity of 25 lb. daily—a total capacity for the entire installation of 1250 lb. daily. Each ozonator is fitted with a number of tubular, stainless steel electrodes into which fit telescopically glass tubes with a conductive coating on their inner surfaces which serves as a second electrode. A special form of electric discharge known as the "ozonator discharge" takes place in the annulus between the inside of the stainless steel tube and the outside of the glass tube.

Fig. 1. Belmont ozonation plant—ozonator and equipment building

Fig. 2. Belmont ozonation plant—group of five rotary compressors

Air passes through the annulus longitudinally. The electric discharge converts part of the oxygen in the air into ozone so that the air leaving the ozonator contains 1% ozone by weight. The ozonized air is collected in manifolds and forced through stainless steel pipe to the ozone–water mixing basins which are outdoors.

High voltage electricity for the discharge enters the ozonator through a side entrance bushing. Each ozonator is provided with an individual transformer which raises the voltage from 460 to 15,000 volts. Ozonators and motors are controlled by individual pushbutton stations. A central panel controls the major electrical circuits and indicates and records information vital to the operation of the plant.

Because ozone is "manufactured" by the individual consumer in ozone plants varying widely in size and operating conditions, the cost of a pound of ozone will differ appreciably from case to case. Under favorable conditions ozone can be produced in quantity for 10 cents a lb. or less; under unfavorable conditions the cost may be 50 cents or even more. Only careful analyses of specific situations will provide the correct answer to the question, "How much does a pound of ozone cost?" (*1*).

More than 50 years ago, it was discovered that ozone had remarkable germicidal properties. It was found that ozone killed almost instantly all water-borne pathogens and left nothing detrimental in the water. This discovery resulted in the installation of a large number of ozone plants, particularly in France, for the disinfection of drinking water. Most of these plants are in operation today, but in this application use of ozone has fallen behind chlorine, which as a disinfectant in drinking water, has proved to be cheaper than ozone. Modern research, nevertheless, has confirmed the early investigations of the germicidal properties of ozone and also has shown it to be extremely effective against such organisms as the virus of infantile paralysis and the cysts of amoebic dysentery.

Present-day methods of applying ozone in water purification can best be shown by again referring to the Belmont Plant of Philadelphia.

Ozone is dispersed into the water to be purified by means of porous carborundum diffusers at the

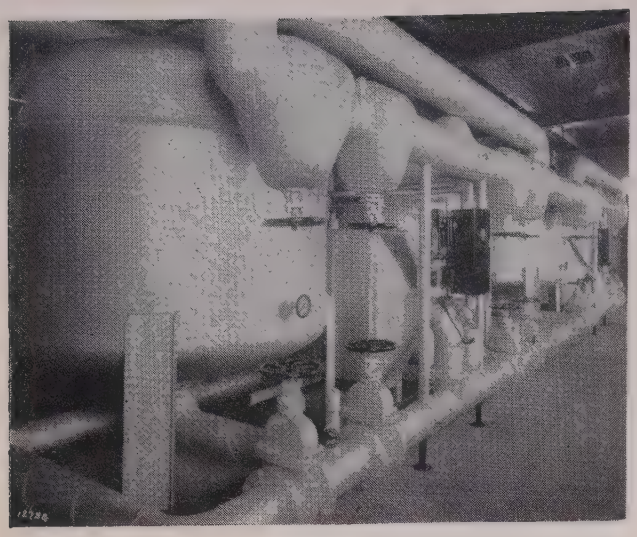

Fig. 3. Belmont ozonation plant—set of two dual tower driers

bottom of the treatment basins or tanks shown in Fig. 6. Three tanks 25 by 25 ft. by about 18 ft. deep are operated in parallel. The water flowing through the tanks has a theoretical detention time of about 10 min. Air stripped of ozone, escapes at the top of the tanks. Although the tanks are shown in the figure with covers removed, they are operated with flat covers to contain the escaping air which is then diluted with about 10 vol. of atmospheric air to dissipate any odor due to unreacted ozone.

At Belmont, ozonation precedes the conventional processes of coagulation and filtration which are necessary to remove turbidity and suspended matter. In cases where ozone is the sole germicide, the water should be filtered prior to ozonation.

Although early investigators were primarily interested in the germicidal properties of ozone, they noted that ozonated water had an improved appearance and taste. It was not until a few years ago, however, that taste and odor consciousness had reached a point in this country where taste and odor quality improvement became a municipal water treatment objective of importance equal to improvement in appearance and in bacteriological quality.

Consumers have become more and more critical of water quality down through the years and high quality water sources have far outrun the demand. Special treatment methods to cope with problems of taste and odor have been a natural result. One of the more important of these special treatment methods is chemical oxidation. There are several means by which oxidation can be achieved, the most effective methods being breakpoint chlorination, chlorine dioxide treatment and ozonation.

In an oxidation type of taste and odor control the objective is to oxidize the taste and odor producing compounds (which occur in very great dilution) to completely tasteless and odorless substances or, to those having at least more pleasing tastes and odors. An example would be the oxidation of sulphide compounds having the odor of rotten eggs to sulphate compounds which at the dilutions involved are odorless and tasteless—and are common constituents of many natural spring waters. Of course, most odoriferous compounds are much more complex than simple sulphides but the principle is the same. Carbon dioxide and water itself are frequently the products of these oxidations.

Phenols, and to a far greater degree chlorinated phenols, are extremely offensive odor-producing compounds. They are commonly found constituents of industrial wastes and cause those obnoxious "medicinal" tastes and odors in water, especially if the water has been disinfected with chlorine as has been common practice in American water plants. Concentrations as low as 5 parts of phenol in 1 *billion* parts of water are sufficient to cause unpleasant tastes and odors. Ozone treatment of water or wastes containing phenols oxidizes them to harmless, tasteless, and odorless products.

At Whiting, Ind., an ozone plant has been in operation for the past 12 years treating a water highly polluted with oil refinery wastes. The incoming Lake Michigan water almost always contains relatively high concentrations of phenol, sometimes as much as 1 p.p.m. Ozonation at Whiting destroys the phenol and prevents development of offensive tastes and odors at the modest cost of $2.00 to $3.00 per million gallons of water. No other taste and odor treatment method will produce a satisfactory water at Whiting except at a prohibitive cost.

Industrial pollutants other than phenols cause unpleasant tastes and odors and natural marine organisms are often responsible for very disagreeable tastes and odors. Oxidation will eliminate or greatly diminish such tastes and odors. In the past 3 years two of the world's largest ozone plants have been installed at Philadelphia and Paris (France) primarily for the control of tastes and odors in the river supplies used by these great cities. At Philadelphia, according to Water Bureau records for 1950, taste and odor as estimated by the standard threshold odor test was reduced 84% by ozonation. The 16% remaining was insufficient to be noticed by other than a trained odor analyst. Operating costs averaged $2.78 per million gallons of water.

The Belmont ozone plant at Philadelphia, while primarily designed for taste and odor control, also removes a very undesirable mineral. Manganese salts are present in Schuylkill River water. These salts

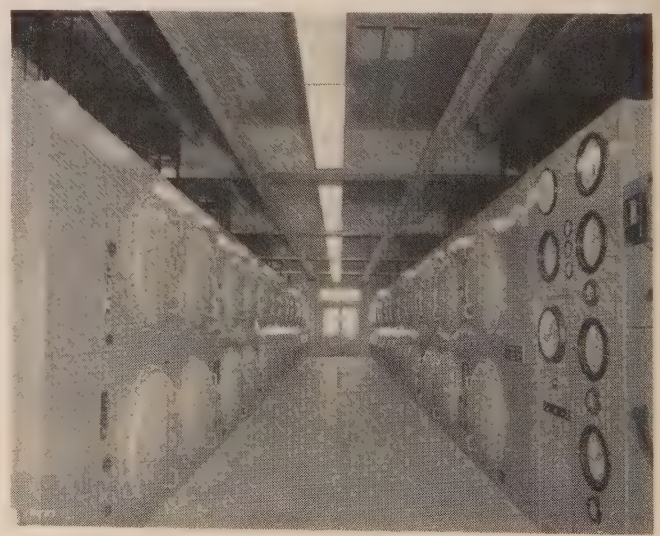

Fig. 4. Belmont ozonation plant—bank of 50 Welsbach ozonators

are colorless in their usual state but, when oxidized by the housewife with disinfectants or bleaches, dark brown manganese dioxide is formed which causes disagreeable brown stains in plumbing fixtures, laundry tubs, clothes, and pots and pans. By oxidizing the manganese salts at the water plant, and removing the resulting manganese dioxide by sedimentation and filtration, manganese is completely eliminated from the water reaching the consumer. Dissolved iron salts, sometimes present in water supplies, act in a similar manner and can also be removed by ozonation and filtration.

High natural color in water is another problem which lends itself to solution by ozonation. Complex organic compounds which impart color to water are oxidized by ozone to colorless substances; ozone is much more effective than other oxidants. While color can usually be reduced by coagulation with alum followed by filtration, often the last increments of color are difficult and expensive to remove. By using ozone alone, or in conjunction with alum, more economical and more complete color removal is often possible. Another important advantage of using ozone for color removal is that filtration facilities are not essential if turbidity is low, thus eliminating the heavy cost of a filter plant.

The cost of ozonation is greatly influenced by the type and severity of the problem. The investment cost of an ozone installation for a moderately large water plant will normally fall in the range of $10,000 to $20,000 for each million gallons of water treatment capacity. Operating costs will range from about $1.00 a million gallons to perhaps $10 in the case of color removal in highly colored waters. For taste and odor problems costs of $2.00 to $3.00 a million gallons are typical.

Fig. 5. Belmont ozonation plant—close-up view of a single ozonator with end-plate removed and an ozone-generating element partially withdrawn

Fig. 6. Belmont ozonation plant—water–ozone mixing tanks

TREATMENT OF INDUSTRIAL WASTES

While the foregoing discussion has been directed primarily toward the purification of water at the water plant, ozone can be used to oxidize the same undesirable compounds in industrial waste waters before they are released to a water supply. In a comprehensive study (*2*) of chemical oxidation of phenols in a coke plant waste, chemical oxidation was found to be the only method which would reduce phenols to the low concentrations necessary to limit the phenol content of the stream to the acceptable 5 parts per billion. Ozone proved to be far more economical and easier to use than chlorine or chlorine dioxide.

A somewhat different ozone application is a unit installed by a utility for oxidation of mercaptans contained in one of its waste waters.

In the related field of air pollution, ozone has been used for a number of years for control of sewage odors. At the Ward's Island treatment plant of the City of New York, gases issuing from sludge holding tanks are being treated with ozone before discharge to the atmosphere to eliminate a neighborhood nuisance. At the new Owl's Head plant now under construction in Brooklyn, sewage treatment tanks and basins are underground. Ventilating air and sewage gases will be treated with ozone before release to the outdoors to prevent unpleasant odors in the recreational and residential areas surrounding the plant.

In the industrial waste field, even more than in water purification, the commercial availability of efficient and dependable equipment to produce ozone *in quantity* promises to make the laboratory Cinderella a much sought-after industrial belle. A powerful oxidant, yet a chemical which adds nothing but oxygen to the reaction, ozone appears to have a bright future, the course of which has just begun to be charted.

LITERATURE CITED

1. Hann, V., *Chem. Ind.* 65: 386–389, 515 (1950).
2. Ohio River Valley Water Sanitation Commission, "Phenol Wastes Treatment by Chemical Oxidation," published by the Commission, Cincinnati, Ohio (1951).

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Development of Design Data for Corrugated Fiberboard Shipping Containers

K. Q. KELLICUTT and E. F. LANDT

The evolution of a formula for predicting the top-to-bottom compressive strength of corrugated A, B, and C-flute boxes from ring-crush or strip-column tests of the component paperboard sheets is discussed. Application of the formula for use in design of corrugated fiberboard boxes to meet specific use requirements is shown. The relationship between the static compressive strength of boxes, dead load of storage, and duration-of-load are included as well as a means of interpreting the known compressive strength of a box having a specific moisture content in terms of another moisture content of the fiberboard.

THE Quartermaster Food and Container Institute for the armed forces has collaborated for several years with the Forest Products Laboratory on a basic study to develop design criteria for use with corrugated fiberboard shipping containers. This investigation included consideration of earlier studies that involved the evaluation of paperboard and corrugated fiberboard as engineering materials and showed the strength properties of the component sheets to be correlated with those of the built-up board (*1*, *3*, *4*). A similar correlation between certain strength properties of a box and those of its components, which would appear to be the next logical step, is the subject of this paper. It describes results, to date, of simplifying and interpreting tests of the components and shows how these results are used in a method that was developed to predict the compressive strength of corrugated fiberboard boxes.

TESTS AND PROCEDURES

Several forms of material and test methods were used in this investigation: (1) component paperboard sheets were subjected to ring-crush, modified ring-crush, and strip-column tests; (2) built-up corrugated boards were given bending, shear, and flexural-shear tests*; (3) fiberboard structures, called tubes, consisting of four panels representing a box without top or bottom were given compression tests; and (4) conventional slotted boxes were given compression tests and were tested in a revolving drum with can-type loads.

Material, Method of Construction, and Size of Tubes and Boxes

Material. All of the tubes and boxes tested were made of double-faced corrugated fiberboard. Some of the A and B-flute board was made on the Laboratory's corrugator and was of balanced construction having the same basis weight of jute or kraft for both liners in combination with either straw, kraft, pinewood, chemfiber, chestnut, or aspen corrugating mediums.

Other boards and boxes were of A, B, and C-flute construction fabricated in commercial corrugated-box factories. Not all of these boards were of balanced construction, although all were made of paperboard component materials currently being used commercially. Some of the boxes were made at the Laboratory from V3c and W6c boards produced commercially. Other V3c boxes tested were made by a commercial fabricator. Samples of the component materials of all the boards were tested.

Method of Constructing Tubes and Boxes. The blank from which each tube was made was cut to the proper size with a sharp power saw in order to eliminate the crushing and tearing of the liners and corrugations along the edges that result when a shearing blade is used for cutting. The joint was made with cloth-backed tape, 3 in. wide, applied to the inside and outside surfaces of the joint and overlapped on each panel about $1^1/_2$ in.

The boxes made and tested were the regular slotted type and had manufacturer's joints fabricated by stitching, tape, or glue. The top and bottom flaps were sealed with adhesive.

Sizes of Tubes and Boxes Tested. Tubes were made from Laboratory boards in a variety of sizes, from 2 to 35 in. square. The heights of the tubes varied from 2 to 48 in.

The tubes and boxes made from commercial materials included not only square but oblong cross sections, in which the length dimensions were either two or three times the width dimension. The perimeters of these tubes and boxes ranged from 16 to 120 in., and their heights were between $6^1/_2$ and $36^7/_8$ in.

Tests of Paperboard Components

Modified Ring-Crush Test. A modified ring-crush test for paperboards, which was developed at the Laboratory, was employed to determine the stress at proportional limit, stress at maximum load, and modulus of elasticity of liners and corrugating mediums. The test specimen consisted of a number of layers of a paperboard strip rolled into the form of a hollow cylinder. The end of the outside lap was secured to the cylinder by a fine line of adhesive. To provide flat ends for insertion in the testing machine, the ends were cast in a compound of ester gum and sealing wax. Two optical strain gages were attached to each specimen.

K. Q. KELLICUTT, Engineer, and E. F. LANDT, Technologist, Forest Products Laboratory, maintained at Madison, Wis., in cooperation with the University of Wisconsin, Forest Service, U. S. Department of Agriculture.

* The procedures for tests of built-up corrugated board and their significance have been previously discussed (*6*) and will not be repeated in this paper.

By measuring compression over a definite gage length on each of two opposite sides of the specimen, reliable data were obtained for use with simultaneous readings of the applied load. Some specimens were prepared so that the load could be applied parallel to the "with-machine" direction of the paper, while others were prepared so that the load could be applied parallel to

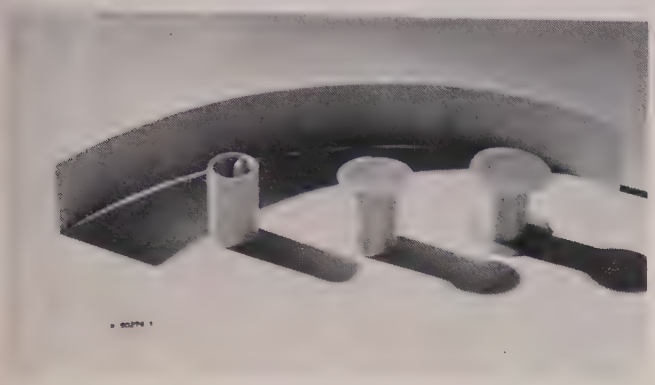

Fig. 1. A specimen for the modified ring-crush test in various stages of preparation

The specimen is prepared by coiling a paper strip (background) on a removable core and casting the ends of the coil. One end has been cast on the specimen in the center. Both ends have been cast on the specimen on the right, which is ready for insertion in the testing machine.

the "across-machine" direction. The components of the modified ring-crush specimen and the specimen in a testing machine are shown in Figs. 1 and 2.

Ring-Crush Test. Ring-crush tests were made by testing $^1/_2$ by 6-in. strips bent into a ring in a specimen holder. The rings were supported on their inner surfaces by the removable centers, or islands, of the holder. The removable islands varied in diameter and were chosen according to the thickness of the specimen. The strips were crushed in a machine that yielded a single value, that of maximum load. The specimen holder for the ring-crush test, and a specimen cutter are shown in Fig. 3.

Strip-Column Test. A strip-column test was made on a specimen 4 in. long that was held straight between two sets of clamp supports, so as to provide a column $^1/_{16}$ in. high. As with the ring-crush tests, only a single value of maximum load was obtained as a result of crushing the column in a testing machine. The clamp employed and the type of test specimen used are shown in Fig. 4.

Compression Tests of Tubes and Boxes

To determine the relationships of size, shape of cross section, and height involved in the bending and crushing of the side walls, compression tests were made of tubes and boxes. The tests were made in a universal testing machine that had a mechanism for making an autographic load-compression curve of each test. Before test the tubes and boxes were conditioned in a controlled atmosphere. The direction of the flutes in the side walls of the tubes and boxes was either vertical (parallel to the direction of the applied load) or horizontal (perpendicular to the applied load).

Drum Tests of Loaded Boxes. A number of drum tests were made of various kinds of boxes, including those made of A, B, and C-flute boards with either jute or kraft liners. The boxes had can-type loads, and the weight of the contents was approximately 1 lb. for each inch of length plus height plus width. Failure was considered complete when the contents spilled from the box during the drum test.

DISCUSSION OF RESULTS

It was apparent in the initial studies at the Laboratory that the strength properties of corrugated fiberboard and the component paperboard materials could be obtained from tests designed to yield engineering information. In the early tests the modulus of elasticity of paperboards, as determined by a tension test, was found to correlate with engineering data from column, bending, and shear tests of the built-up corrugated board. It was desired also to determine if a similar correlation could be obtained for compressive stresses. The modified ring-crush test, one of the more precise tests for compressive stresses, was found to be useful in correlating the maximum crushing loads of

Fig. 2. A specimen for the modified ring-crush test, with two optical strain gages attached, is oriented in the testing machine. The ends of two auto-collimators, for reading the gages, may also be seen

fiberboard tubes with the maximum crushing strength of paperboard. Its principal use in this study, however, was to evaluate simpler tests, such as the ring-crush and strip-column tests. Both the ring-crush and strip-column tests are considered suitable for use by

industry, and it appeared logical to explore the feasibility of using them in accomplishing the main objectives of this investigation.

Evolution of a Design Formula

One of the main objectives of this investigation was to develop a method of expressing the crushing strength of a corrugated fiberboard box using information obtained from a simple test of the component paperboard sheets. In the development of this method, the tube was used as the intermediate link between tests of the components and of the box. Therefore, the mathematical relationships involved in the bending and crushing of thin plates representing each of the four walls of a fiberboard box were initially established for the tube.

As paperboard is a nonisotropic material, it was recognized that a formula applicable to fiberboard with the load applied parallel to the machine direction might not be applicable to fiberboard with the load applied perpendicular to the machine direction of the fourdrinier or cylinder paperboards. With these recognized characteristics as a guide a basic formula was evolved for the crushing strength of a tube that paralleled data developed at the Forest Products Laboratory for applying the thin-plate theory of mechanics to the design of panels of plywood (*7–10*).

Relationship of Static Tube and Box Loads

The static compressive strength of tubes represents

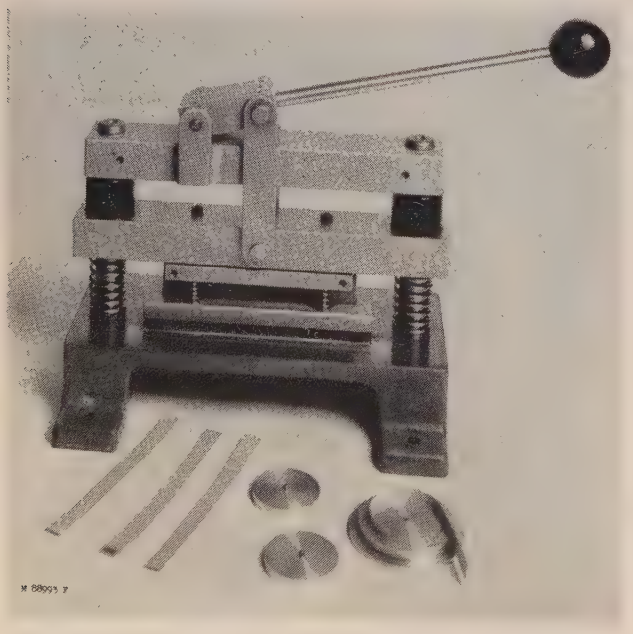

Fig. 3. Strips of paperboard $^1/_2$ by 6 in., left front, are cut for the ring-crush test with the specimen cutter in the background. The specimen holder for the ring-crush test is shown at the right front with a paperboard strip partially inserted in it. In the center front are two removable islands for the specimen holder that are used with other thicknesses of paperboard

the optimum that may be obtained with any given corrugated board, and it follows that this optimum compressive strength will not be attained in corresponding corrugated fiber boxes because of various factors that enter into their manufacture and use. Hence, in order to use the formula developed for the crushing strength of a tube for design purposes, it was necessary to establish the relationship between the loads attained by tube and by the box.

To determine the relationship of the crushing strength of fiberboard tubes to the top-to-bottom crushing strength of the finished fiberboard box, comparisons of

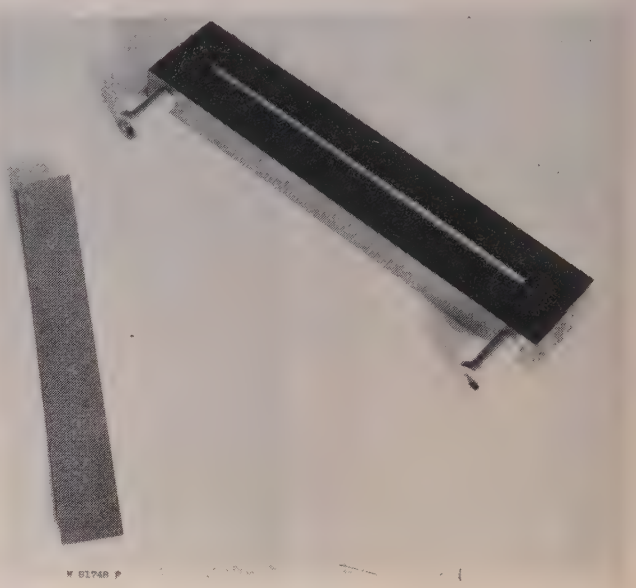

Fig. 4. The strip of paperboard, $^9/_{16}$ by 4 in., held in the metal clamps at the right, is ready for the strip-column test. A $^1/_{16}$-in.-high column of paperboard is provided above the top surface of the clamps. A test specimen is shown on the left.

tube and box loads for corresponding sizes were made. These comparisons, which included boxes and tubes with square and oblong cross sections in various heights, showed that the relationship was fairly constant up to certain limits. For instance, for tube loads up to about 1500 lb., the box loads were approximately 0.7 of the corresponding tube loads. For tube loads greater than 1500 lb., the ratio of box loads to tube loads was no longer constant but decreased with an increase in tube load. It was observed that the tube loads continued to increase beyond the 1500-lb. value, while the corresponding box loads did not change appreciably.

In general, the maximum load that tubes of a given cross section withstood decreased with an increase in height from 2 in. up to 12 or 16 in. depending upon the kind of material from which the tube was made. A further increase in height had little influence on resistance to crushing. This can be explained by the fact that the 12, 14, or 16-in. heights represent the wavelength into which any particular combination of material would shape itself under stress and that the greater heights were merely multiples of this wave length (*2*). This fact is illustrated by the tests of the two tubes shown in Figs. 5 and 6.

Increases in the compression strength of boxes did not occur, however, with decreases in height. This can be accounted for, at least in part, by the end condition of the side panels of the box. Rolling and bending takes place along the horizontal score, which

is one of the weaker points in a box, and usually causes premature buckling. As a result the loads attained by shorter panels in a box are not greater than those attained by higher panels as they are in a tube where normal buckling occurs. Although some differences in loads were attained for boxes of various heights, for

Fig. 5. Compression test of a 12 by 12 by 12-in. tube showing a wave in the direction of applied load. The tube shown was fabricated from B-flute board having 0.030-in. jute liners and 0.009-in. straw corrugations

practical purposes, the box loads were considered the same for a specific cross section, regardless of height.

Determination of Box Factors

The box factor, or ratio of box load to tube load, for various cross sections and for heights of 12 in. and greater was reasonably constant. For heights of less than 12 in., however, there was considerable divergence between the box and tube loads. This was because tube loads increased with decreasing heights while the box loads remained about constant throughout the range. Therefore, to eliminate this divergence by deriving a box factor that would apply regardless of the shape of the box, it was necessary to relate the box to a tube in which the ratio of the width of a side panel to the height of the panel was 1.5 or less.

Although it was found that a single box factor could be used for a specific flute, the same factor could not be used for all three flutes. Hence, box factors were determined for A, B, and C-flute boxes, so that box loads could be predicted from the basic tube formula. Further, it was found that the box factor provided a means for adjusting box loads for the specific kinds of body joints. Some tentative box factors that were determined are included in Table I.

Alignment Charts for Application of Formula to Boxes

To simplify use of the formula for boxes, alignment charts for calculating the strength of A, B, or C-flute boxes were constructed (*6*). A typical chart, for A-flute boxes, is shown in Fig. 7. To use the alignment charts, determine the combined ring-crush strength of the single-face liner (S.F.L.), the double-back liner

Table I. Tentative Box Factors for A, B, and C-Flute Boxes

Source of boxes	*Type of manufacturer's joint*	*Box factors for boxes with flutes vertical in side walls*[a] — *Flute*		
		A	*B*	*C*
Laboratory made from commercial material	Taped	0.717	0.752	0.717
	Stapled	...	0.622	...
Commercially made	Taped	0.667	0.597	0.667
	Stapled	...	0.564	...

[a] Box factors for boxes with flutes horizontal in side walls have not been determined.

Fig. 6. Compression test of a 12 by 12 by 48-in. tube showing longitudinal waves just before the maximum load was reached. The tube was fabricated from the same board used for the tube in Fig. 5. The load for the two tubes was about equal

(D.B.L.), and the corrugating medium (C.M.). For A-flute boxes, this strength is determined by the formula

$$\text{S.F.L.} + \text{D.B.L.} + (1.523 \times \text{C.M.})$$

For B and C-flute boxes, the same formula is used, except that the take-up factor for the corrugating medium will be 1.361 and 1.477 for B and C-flute boxes, respectively. With the combined ring-crush strength and the appropriate box factor the top-to-bottom crushing strength can be determined from the alignment charts as illustrated for A-flute boxes in Fig. 7.

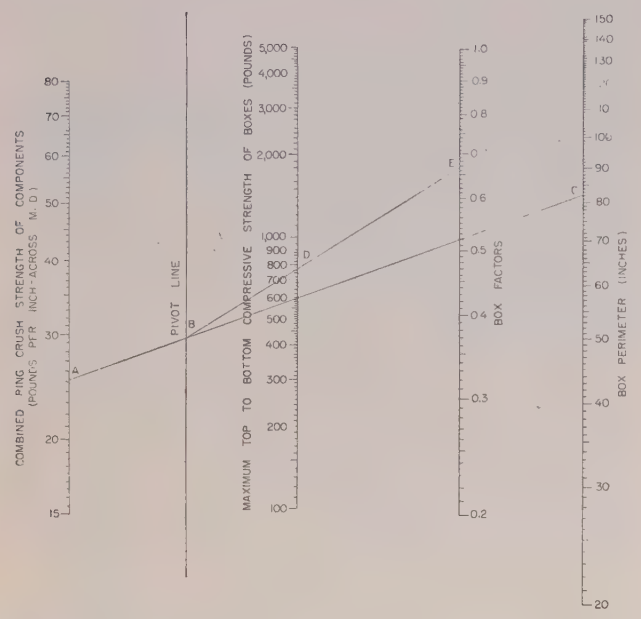

Fig. 7. Alignment chart for determining the top-to-bottom compressive strength of A-flute corrugated fiberboard boxes when the flutes are vertical in the side walls. The resulting determinations will be for a box conditioned in the same atmosphere in which the ring-crush strength values were obtained

Using a straightedge, connect the appropriate combined ring-crush strength, point A, with the box perimeter, point C. With point B as a pivot, orient the straightedge with the box factor, point E, and read the load on the compressive strength scale at point D.

Stacking Strength of Boxes

The compressive strength provides an index for determining other significant properties of the box of which one of the most important is stacking strength. It is known that corrugated fiberboard boxes cannot be expected to support indefinitely a stacking load equivalent to the load attained by a compression test of the box in a testing machine. Although some large users of fiberboard containers have established their own stacking limits for boxes in storage (*4*), and some basic studies on stacking loads are in progress, more work is needed to determine the portion of the compression test value that the box can be expected to support for specific periods of time in various storage atmospheres.

To determine the information deemed necessary to establish load limits for specific periods of storage, long-time loading tests were made of several kinds of A and B-flute boxes in several different atmospheres (*5*). The results thus far obtained indicate clearly defined trends and relationships between the compression test value of a box, as determined in a testing machine, the magnitude of the dead load of storage, and the duration of loading. These relationships were the same for various atmospheres. Hence, it was determined that the influence of moisture content of the fiberboard could be tied in directly with design by determining its influence on compressive strength.

Relation of Moisture Content of Fiberboard to Compressive Strength

The influence of moisture content on the compressive strength of various lots of boxes, made of different materials, was determined. A formula was derived (*5*) with which the compressive strength of a box at a specific moisture content may be found by relating the box to one for which the compressive strength and moisture content are known.

For easier use of the relationship, an alignment chart was constructed from which the compressive strength of boxes at one moisture content can be readily interpreted in terms of another moisture content (*5*).

Resistance to Rough Handling in the Revolving Drum

Although it was anticipated that general trends could be established, a close correlation between compressive strength and the results of rough-handling tests in the hexagonal drum was not expected. Past experience had shown that the drum test is less precise than the compression test, and that test values vary more for boxes tested in the drum than for those tested in the compression machine. Generally, the boxes that attained the greatest compressive loads also attained the greatest number of falls in the drum.

HOW CAN BASIC DESIGN DATA BE USED

It is believed that the information obtained in this study of fiberboard boxes and their basic component paperboard sheets can be used:

1. To prepare tables and charts for design purposes and general specifications applicable to various box sizes, load limits, and, perhaps, commodity classifications.
2. To develop design criteria that can be used by the box manufacturer in quality-control operations as well as for design purposes to meet specific use requirements or standards.

LITERATURE CITED

1. Carlson, T. A., *Fibre Containers* 24, No. 7: 22, 24, 26, 28–31, 34–35 (1939).
2. Carlson, T. A., *Am. Management Assoc. Proceedings.* Ser. 128: 23–29 (1941).
3. Carlson, T. A., *Paper Trade J.* 112, No. 23: 35–38 (1941).
4. Grundy, A. V., *Fibre Containers* 25, No. 7: 16, 20, 22 (1940).
5. Kellicutt, K. Q., and Landt, E. F., *Fibre Containers* 36, No. 9: 28, 30, 35–36, 38 (1951).
6. Kellicutt, K. Q., and Landt, E. F., U. S. Forest Products Laboratory Report No. D1911, *Fibre Containers* 36, No. 12: 62, 67–68, 70, 75–76, 78, 80 (1951).
7. March, H. W., U. S. Forest Products Laboratory Report No. 1583 (1948).
8. March, H. W., Kuenzi, E. W., and Kommers, W. J., U. S. Forest Products Laboratory Report No. 1301 (1942).
9. March, H. W., and Smith, C. B., U. S. Forest Products Laboratory Report No. 1505 (1949).
10. Norris, C. B., National Advisory Committee on Aeronautics Tech. Note No. 1251 (1947).

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Corrosion of Alkaline Pulping Digesters

Analysis of Corrosion Questionnaires

R. S. PEOPLES and G. L. ERICSON

This report contains the results of a study of information obtained from replies to a questionnaire sent to 63 pulp mills in regard to corrosion problems in the industry. The information revealed that corrosion has been significantly greater in digesters installed during the last 10 yr. For example, of the digesters in operation during this period, 24% showed corrosion rates of over 100 mils per yr., while essentially 100% of those in operation prior to this time showed rates of less than 50 mils per yr. The data submitted, though thoroughly screened, were not adequate to establish whether the observed trend was the result of (1) changes in operational and processing procedures, (2) type and quality of the steel, or (3) as yet unidentified variables. To determine the reasons for this trend, it would be necessary to: (1) Obtain more precise and detailed information from either all the mills or selected mills in the industry with respect to processing procedures and data. (2) Obtain more comprehensive and accurate corrosion information in regard to rates, type, and location of attack. (3) Obtain a more complete chemical analysis of metal samples from digesters undergoing corrosion examination. (4) Make a complete microscopic examination of representative metal samples, both from digesters giving long life and from those showing high rates of attack. (5) Secure more comprehensive data with respect to metal processing and fabrication on individual digesters.

THE Digester Corrosion Committee of the Technical Association of the Pulp and Paper Industry compiled an extensive quextionnaire which was sent to kraft and soda pulp mills in the United States and Canada. The primary purpose of this questionnaire was to obtain data which would aid the Corrosion Committee in correlating information in connection with digester corrosion problems.

In December, 1951, Battelle undertook to analyze and summarize the information and data included in the returned questionnaires.

Questionnaires analyzed represented 50 United States mills, 12 Canadian mills, and 1 Australian mill. Data were reported for a total of 610 digesters, of which 492 were located in the United States, 110 were Canadian, and 8 Australian. Of the 610, a total of 108 have been removed from service because of excessive corrosion. The length of service for the 108 retired digesters varied from 1.7 to 34.0 yr.

The reported digesters can be further broken down into the following categories:

UNITED STATES

Kraft stationary	332 digesters
Kraft rotary	87 digesters
Soda stationary	42 digesters
Soda rotary	15 digesters
Modified soda	16 digesters

CANADIAN

Kraft stationary	91 digesters
Kraft rotary	19 digesters

AUSTRALIAN

Kraft stationary	8 digesters

The results of the analysis are contained herein.

ANALYSIS OF DATA REPORTED IN QUESTIONNAIRES

A critical examination of the questionnaires showed that many of the mills had devoted considerable thought and effort to reporting on the various items for which they had information. All mills reported information on essentially all items in the questionnaires pertaining to digester operating procedures and processing data, and on some specific points, such as type of digester, constructional details, fabrication code, class, and ASTM number of steel and manufacturer of digester. Tabulation of the data on the 63 questionnaires showed that only 30 United States mills and 8 Canadian mills reported any type of corrosion information. These covered 205 digesters (189 kraft, 16 soda) and represented only 30% of the digesters reported in the questionnaires. In addition, of this 30%, many of the corrosion data were either incomplete or of doubtful quality.

In the foregoing discussion, it should be pointed out that the validity of the conclusions which may be drawn from information contained in a questionnaire is entirely dependent on the quality of the data reported. This should not be construed as adverse criticism of the present questionnaire, its object, or of the mills replying to the questionnaire. It is a fact, however, which must be considered in analyzing the data and arriving at trends and conclusions.

With the exception of possibly four of the mills reporting corrosion data, the corrosion rate expressed in inches or mils per year was calculated from the entire service life or length of service of the digester. Obviously, this is not a current rate and such a rate would not necessarily reflect changes in, say, yearly corrosive conditions brought about by changes in operating and processing procedures. Many other mills reported corrosion rates in such a manner that there would be considerable doubt as to their validity. Ten of the mills showed total losses at the thinnest sections (or a corrosion rate) which were identical for all the digesters they reported. It would be extremely unlikely that all digesters operating in the same mill would exhibit exactly the same corrosion rate or behavior. Consequently, the accuracy of this type of corrosion data would be questioned.

Many mills reported total loss of metal at the thinnest section to the nearest $^1/_4$ or $^1/_2$ in., with no indication

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Report on Analysis of Corrosion Questionnaires to the Chemical Engineering Committee and the Digester Corrosion Subcommittee of the Technical Association of the Pulp and Paper Industry by the Battelle Memorial Institute, Columbus, Ohio, under TAPPI research grant no. 26.

Table I. Data for Kraft Digesters Reported by Six United States Mills

Questionnaire No.	Digester No.	Years of service	Total loss at thinnest section, in.	Reported current corrosion rate, in./yr.	Corrosion rate based on total service, in./yr.	Corrosion allowance, in.	Reported change in corrosion rate	ASTM No. of steel	No. of cooks per year	Time of cook, hr.	Cooking data: Temp., °F.	Cooking data: Pressure, p.s.i.	Size of digester: Diameter Ft.	Size of digester: Diameter In.	Size of digester: Height Ft.	Size of digester: Height In.	Yield per digester, tons per cook	Sulphidity range, %
38	1	10.0	0.062	...	0.010	0.125	Const.	A-70	1750	3.0	78	110[b]	9	6	40	0	8.0	22–23
	2	10.0	0.052	...	0.010	0.125	Const.	A-70	1750	3.0	78	110[b]	9	6	40	0	8.0	22–23
	3	5.3	0.060	...	0.012	0.125	Const.	A-70	1750	3.0	78	110[b]	9	6	40	0	8.0	22–23
	4	3.7	0.055	...	0.012	0.125	Const.	A-70	1750	3.0	78	110[b]	9	6	40	0	8.0	22–23
	5	2.2	0.020	...	0.014	0.125	Const.	A-285C	1750	3.0	78	110[b]	9	6	40	0	8.0	22–27
41	1	13.3	0.478	...	0.036	0.125	Const.	ASME S-1	1250	4.0	...	105[b]	10	6	44	3	9.5	22–28
	2	13.3	0.406	0.037	0.030	0.125	Const.	ASME S-1	1250	4.0	...	105[b]	10	6	44	3	9.5	22–28
	3	13.3	0.625	0.057	0.047	0.125	Const.	ASME S-1	1250	4.0	...	105[b]	10	6	44	3	9.5	22–28
	4	10.3	0.323	0.042	0.031	0.125	Const.	ASME S-1	1350	4.0	...	105[b]	10	6	44	3	9.5	22–28
	5	10.3	0.219	0.037	0.021	0.125	Const.	ASME S-1	1350	4.0	...	105[b]	10	6	44	3	9.5	22–28
	6	10.3	0.219	0.037	0.021	0.125	Const.	ASME S-1	1350	4.0	...	105[b]	10	6	44	3	9.5	22–28
			Cone *Shell*		*Cone* *Shell*	*Cone* *Shell*												
17	1[a]	8.3	1.000 0.375	...	0.121 0.045	0.415 0.14	....	A-70	2310	3.0	334	100	10	6	42	0	8.0	18–25
	2[a]	8.3	1.015 0.468	...	0.122 0.056	0.415 0.14	...	A-70	2310	3.0	334	100	10	6	42	0	8.0	18–25
	1N[a]	3.5	0.906 0.945	...	0.262 0.274	0.79 0.415	...	A70-42	2524	3.0	334	100	10	6	42	0	8.0	18–25
	2N	5.5	0.950 0.725	...	0.175 0.134	0.79 0.415	...	A70-42	2524	3.0	334	100	10	6	42	0	8.0	18–25
	3N	5.5	0.970 0.705	...	0.180 0.131	0.79 0.415	...	A70-42	2524	3.0	334	100	10	6	42	0	8.0	18–25
	4N	5.5	0.850 0.775	...	0.160 0.145	0.79 0.415	...	A70-42	2524	3.0	334	100	10	6	42	0	8.0	18–25
	5N[a]	3.8	... 0.960	...	... 0.256	0.79 0.415	...	A70-42	2524	3.0	334	100	10	6	42	0	8.0	18–25
44	1	16.0	0.094	0.007	0.006	...	Unknown	A-7033	2640	3.0	354	115	8	0	34	0	3.3	20–27
	2	16.0	0.125	0.009	0.008	...	Unknown	A-7033	2640	3.0	354	115	8	0	34	0	3.3	20–27
	6	14.3	0.281	0.023	0.020	...	Unknown	A-285	1584	5.0	354	115	10	0	41	0	6.0	20–27
9	1[a]	13.5	0.42	...	0.033	0.156	Incr.	S-1	2400	2.4	...	110	9	9	42	0	8.4	22–28
	2[a]	14.1	0.42	...	0.032	0.156	Incr.	S-1	2400	2.4	...	110	9	9	42	0	8.4	22–28
3	3	14.2	0.38	...	0.029	0.156	Incr.	S-1	2400	2.4	...	110	9	9	42	0	8.4	22–28
	4	14.2	0.34	...	0.026	0.156	Incr.	S-1	2400	2.4	...	110	9	9	42	0	8.4	22–28
	5[a]	12.7	0.44	...	0.036	0.156	Incr.	S-1	2400	2.4	...	110	9	9	42	0	8.4	22–28
	6	13.2	0.38	...	0.031	0.156	Incr.	S-1	2400	2.4	...	110	9	9	42	0	8.4	22–28
	7	13.2	0.34	...	0.028	0.156	Incr.	S-1	2400	2.4	...	110	9	9	42	0	8.4	22–28
	8	13.2	0.38	...	0.031	0.156	Incr.	S-1	2400	2.4	...	110	9	9	42	0	8.4	22–28
	9[a]	12.2	0.46	...	0.039	0.156	Incr.	S-1	2400	2.4	...	110	9	9	42	0	8.4	22–28
	10	12.7	0.34	...	0.029	0.156	Incr.	S-1	2400	2.4	...	110	9	9	42	0	8.4	22–28
	11[a]	12.6	0.48	0.075	0.038	0.156	Incr.	S-1	2400	2.4	...	110	9	9	42	0	8.4	22–28
	12	12.7	0.31	...	0.027	0.156	Incr.	S-1	2400	2.4	...	110	9	9	42	0	8.4	22–28
	13	12.7	0.38	0.120	0.030	0.156	Incr.	S-1	2400	2.4	...	110	9	9	42	0	8.4	22–28
	14	7.7	0.25	...	0.039	0.156	Incr.	A-70	2400	2.4	...	110	9	9	42	0	8.4	22–28
	15	7.7	0.24	...	0.035	0.156	Incr.	A-70	2400	2.4	...	110	9	9	42	0	8.4	22–28
	16	2.7	0.18	...	0.067	0.156	Incr.	A-70	2400	2.4	...	110	9	9	42	0	8.4	22–28
	17	2.9	0.22	0.200	0.080	0.156	Incr.	A-70	2400	2.4	...	110	9	9	42	0	8.4	22–28
	18	2.0	0.10	0.092	0.050	0.156	Incr.	A-285 Gr. C	2400	2.4	...	110	9	9	42	0	8.4	22–28
	19	2.0	0.10	0.075	0.050	0.156	Incr.	A-285 Gr. C	2400	2.4	...	110	9	9	42	0	8.4	22–28
	20	2.0	0.19	0.142	0.095	0.156	Incr.	A-285 Gr. C	2400	2.4	...	110	9	9	42	0	8.4	22–28
7	1	2.5	0.135	...	0.045	0.750	Incr. slightly	A70-44	2600	3.0	...	100	8	0	31	8	3.7	23–27
	2	2.5	0.135	...	0.045	0.750	Incr. slightly	A70-44	2600	3.0	...	100	8	0	31	8	3.7	23–27
	3	8.5	0.445	...	0.045	0.750	Incr. slightly	A70-39	2600	3.0	...	100	8	0	31	8	3.7	23–27
	5	19.5	0.455	...	0.046	0.750	Incr. slightly	A-89	2600	3.0	...	100	8	0	31	8	3.7	23–27
	6	19.5	0.735	...	0.037	0.750	Incr. slightly	A-89	2600	3.0	...	100	8	0	31	8	3.7	23–27
	7	19.5	0.495	...	0.025	0.750	Incr. slightly	A70-36	2600	3.0	...	100	8	0	31	8	3.7	23–27
	8	11.5	0.345	...	0.029	0.750	Incr. slightly	A70-36	2600	3.0	...	100	8	0	31	8	3.7	23–27
	11	11.5	0.435	...	0.036	0.750	Incr. slightly	A70-36	2600	3.0	...	100	8	0	31	8	3.7	23–27
	12	11.5	0.465	...	0.039	0.750	Incr. slightly	A70-36	2600	3.0	...	100	8	0	31	8	3.7	23–27
	13	11.5	0.305	...	0.025	0.750	Incr. slightly	A70-36	2600	3.0	...	100	8	0	31	8	3.7	23–27
	14	11.5	0.445	...	0.037	0.750	Incr. slightly	A70-36	2600	3.0	...	100	8	0	31	8	3.7	23–27
	15	11.5	0.615	...	0.051	0.750	Incr. slightly	A70-36	2600	3.0	...	100	8	0	31	8	3.7	23–27
	16	11.5	0.695	...	0.058	0.750	Incr. slightly	A70-36	2600	3.0	...	100	8	0	31	8	3.7	23–27

18	19.5	0.495	0.025	0.750	Incr. slightly	A-89	2600	3.0		100	8	0	31	8	3.7	23-27
19	19.5	0.715	0.036	0.750	Incr. slightly	A-89	2600	3.0		100	8	0	31	8	3.7	23-27
20	8.5	0.395	0.040	0.750	Incr. slightly	A70-39	2600	3.0		100	8	0	31	8	3.7	23-27
21	8.5	0.395	0.040	0.750	Incr. slightly	A70-39	2600	3.0		100	8	0	31	8	3.7	23-27
22	8.5	0.325	0.033	0.750	Incr. slightly	A70-39	2600	3.0		100	8	0	31	8	3.7	23-27
23	2.5	0.125	0.042	0.750	Incr. slightly	A70-44	2600	3.0		100	8	0	31	8	3.7	23-27
24	2.5	0.125	0.042	0.750	Incr. slightly	A70-44	2600	3.0		100	8	0	31	8	3.7	23-27

[a] Out of service. [b] Pressure at blow.

Table II. Data for Kraft Digesters Reported by Two Canadian Mills

Questionnaire No.	Digester No.	Years of service	Total loss at thinnest section, in.	Reported current corrosion rate, in./yr.	Corrosion rate based on total service, in./yr.	Corrosion allowance, in.	Reported change in corrosion rate	ASTM No. of steel	No. of cooks per year	—Cooking data— Time of cook, hr.	Temp. °F.	Pressure, p.s.i.	—Size of digester— Diameter Ft.	In.	Height Ft.	In.	Yield per digester, tons per cook	Sulphidity range, %
59	1[a]	14.2	0.750	0.044	0.053	0.187		A-70	1179	3.0			9	6	33	0	4.3	25-34
	2[a]	21.6	0.563	0.022	0.026	0.187		A-89	1179	3.0			9	6	33	0	4.3	25-34
	3[a]	21.6	0.488	0.017	0.020	0.187		A-89	1179	3.0			9	6	33	0	4.3	25-34
	4[a]	19.2	0.313	0.013	0.016	0.187		A-89	1179	3.0			9	6	33	0	4.3	25-34
	5[a]	11.7	0.750	0.031	0.064	0.187		A70-33	1179	3.0			9	6	33	0	4.3	25-34
	4N	0.8	0.15	0.018	0.019	0.375		A-285 GRC	1998	3.0			11	3	36	5	6.1	18.7-38.8
	6N	2.1	0.13	0.062	0.375			A70-44	1950	3.0			11	3	36	5	6.1	18.7-38.8
53	1	4.0	0.250	0.063	0.205			A70-42	1900	4.1	340	100	10	2	47	6	8.5	25-33
	2	4.0	0.300	0.075	0.205			A70-42	1900	4.1	340	100	10	2	47	6	8.5	25-33
	3	4.0	0.200	0.050	0.205			A70-42	1900	4.1	340	100	10	2	47	6	8.5	25-33
	4	4.0	0.420	0.105	0.205			A70-42	1900	4.1	340	100	10	2	47	6	8.5	25-33
	5	4.0	0.400	0.100	0.205			A70-42	1900	4.1	340	100	10	2	47	6	8.5	25-33
	6	4.0	0.300	0.075	0.205			A70-42	1900	4.1	340	100	10	2	47	6	8.5	25-33
	7	4.0	0.400	0.100	0.205			A70-42	1900	4.1	340	100	10	2	47	6	8.5	25-33

[a] Out of service.

as to how the measurement was obtained or as to its accuracy. In making the measurement, an error of $^1/_{16}$ in. on a reported reduction in thickness of $^1/_4$ in. would change a corrosion rate by ±33%. The validity of such information would be questioned. A few mills reported their corrosion data to the nearest mill and described how the data were obtained. Such data, in all probablity, would be more accurate.

Of the 38 mills reporting corrosion data, six United States and two Canadian included corrosion information which appeared to be the most accurate and reliable. All digesters were stationary and represented the kraft operation. These data were examined in more detail. The corrosion data, together with what were considered the most pertinent operating and processing data, were tabulated. All of these mills reported total loss at the thinnest section based on recent audigage measurements. The tabulation for the six United States mills is contained in Tables I and III and for the two Canadian mills in Tables II and IV.

Analysis of Data from Six Selected United States Mills

From the reported data, it was possible to draw a comparison between current digester corrosion rates (a rate based on the most recent observation) and overall corrosion rates (a rate based on entire service life).

Two of the United States mills reported that their current corrosion rate was increasing. One of these two mills reporting on 20 digesters showed rates (based on total service life) ranging from 29 to 39 mils per yr. for 15 digesters which had been in service approximately 8 to 14 yrs. Two of these 15 digesters are now showing current corrosion rates of 75 to 120 mils per yr. Five of the 20 digesters have been in service 2 to 3 yr. Four of these five are showing current corrosion rates ranging from 75 to 200 mils per yr. and, in every case, the current rate is considerably higher than the reported rate based on total service (2 to 3 yr.). This certainly indicates that digesters in this mill are showing an increasing corrosion rate. The other mill indicated that they felt their corrison rate was increasing slightly. Their reported corrosion data on 20 digesters bore this out to a degree. Four digesters in service 2 to 3 yr. showed rates ranging from 42 to 45 mils per yr. (43 mils average), while 16 which have been in service 8 to 20 yr. showed rates ranging from 25 to 58 mils per yr., with an average of 38 mils per yr.

Another of the six mils reported corrosion data (based on total service) on the cone and shell sections of seven digesters. Two which had been in operation during the period 1937 to 1945 showed corrosion rates ranging from 45 to 122 mils per yr., while five operating since 1945 have shown rates ranging from 134 to 274 mils per yr. Even though all the reported rates are quite excessive, the data show a trend toward increasing corrosion rates.

Two of the six mills indicated that their corrosion rate was constant, while one showed it to be unknown. All 14 digesters reported by these three mills showed rates considerably below 50 mils per yr., averaging approximately 20 mils, with no indication that recently installed digesters were corroding at a greater rate than older digesters. It was not possible from the

Service bracket, yr.	Corrosion bracket, mils/yr. 0–10	11–30	31–50	51–70	71–100	Over 100	No. of digesters
0–10	10.3%	13.8%	44.9%	3.4%	3.4%	24.2%	29
11–20	6.5%	35.5%	51.5%	6.5%	...	....	31

data available to determine the reason for the low corrosion rate in these digesters.

A comparison can be drawn between the corrosion behavior of digesters in operation in the last 10 yr. and the behavior of those which were placed in service prior to this time.

The corrosion data based on total service life reported by the above six mills, on a total of 60 kraft digesters, were arranged to show the percentage falling within a certain corrosion rate and service bracket, regardless of the mill they represented. These data are shown in the tabulation above.

It can be seen that, of the 29 digesters which have been in operation during the past 10 yr., 31% have shown rates higher than 50 mils per yr. In the case of the 31 digesters in the 11 to 20-yr. bracket, only 6.5% show rates above 50 mils per yr. and none above 71. These data would seem to indicate that some digesters installed within the past 10 yr. are corroding at a higher rate than those installed prior to this time.

The reason for this apparently higher corrosion rate of some of the more recently installed digesters cannot be ascertained from the information submitted on any of the six questionnaires. The data submitted on such operational and processing items as liquor analysis, sulphidity, amount of black and white liquor, cooking time, pressure and temperature, yield in tons, type of wood, chemical make-up, etc., are either typical or average. They do not indicate changes which might occur over certain definite periods of time which would affect corrosion drastically. Any attempt to arrive at a correlation between reported variations of these typical data and variations in corrosion rates (based on total service life) could lead to misleading conclusions.

All six mills reported approximately the same range in sulphidity of 18 to approximately 28%. This is essentially the range for all kraft mills reporting corrosion information. It is quite possible that major variations in the sulphidity could affect the corrosiveness of the liquor. However, this could not be ascertained from the data.

Variations in the amount of white and black liquor used in the pulping operation could affect corrosivity to some extent. This is not indicated from the data reported by the six mills under consideration. The mill reporting the highest corrosion rates (over 200 mils per yr.) used 60% white to 40% black liquor, which was essentially the same as the mill reporting corrosion rates of less than 12 mils per yr. Two of the mills reported low corrosion rates for their digesters, of about the same order of magnitude. However, one of these mills reported that they used 36% white liquor and the other mill 70%.

Examination of the analytical data for white and black liquors, type and quantity of make-up chemicals, and species of wood showed some variation among the six mills. No relationship could be established between the reported variations and the corrosion performance of digesters.

There was considerable variation in cooking time and number of cooks per year reported for the various digesters representing the six mills. A corrosion rate was calculated for these digesters by multiplying the number of cooks per year times the cooking time in hours times the years of service divided by the number of hours in a year. This figure, together with the total loss of metal at the thinnest point, was used to secure a corrosion rate based on total cooking time in years. It was felt that such a figure would place all digesters on a more equivalent basis for comparison. However, this assumes that all corrosion takes place during cooking which, obviously, is not a completely valid assumption. These rates are included in Table V. For the most part, the rates based on "total cooking time" are somewhat higher than the reported corrosion rates (based on total years of service and total metal loss at the thinnest section) for each digester. Comparison of all digesters on either rate basis does not significantly change the relative position of any individual digester.

Table III. Analytical Data and Quantity of White and Black Liquor for the Six United States Mills

Questionnaire No.	Analysis of white liquor	Analysis of black liquor	Heavy liquor	Weak liquor	Quantity of white liquor used per cook	Quantity of black liquor used per cook
38	0.65 lb./gal. NaOH as Na_2O 0.25 lb./gal. Na_2S as Na_2O 0.16 lb./gal. Na_2CO_3 as Na_2O	Sodium compounds of lignin, sugar, etc. From wood; small portions of sodium Hydroxide, sodium sulphide, and sodium carbonate			5000 gal. 69 %	2300 gal. 31 %
41	4.8 lb./cu. ft. NaOH 1.32 lb./cu. ft. Na_2S 1.32 lb./cu. ft. Na_2CO_3	No data			915 cu. ft. 88%	210 cu. ft. 12%
17	83 g./l. NaOH as Na_2O 27 g./l. Na_2S as Na_2O 24 g./l. Na_2CO_3 as Na_2O	% Total solids % Organic % Inorganic sodium salts	63 52 47.5	... 56.65 43.3	5220 gal. per day 60%	3530 gal. per day 40%
44	5.1 lb./cu. ft. NaOH as Na_2O 1.6 lb./cu. ft. Na_2S as Na_2O 1.1 lb./cu. ft. Na_2CO_3 as Na_2O	1.3 lb./cu. ft. active alkali as Na_2O 0.8 lb./cu. ft. NaOH 0.5 lb./cu. ft. Na_2S			540 cu. ft. 36%	960 cu. ft. 64%
9	95 g./l. NaOH 44 g./l. Na_2S 32 g./l. Na_2CO_3	Total solids, 15%			Paper cook, 715 cu. ft. Board cook, 640 cu. ft.	Paper cook, 430 cu. ft. Board cook, 510 cu. ft.
7	122 g./l. total Na_2O 75 g./l. NaOH as Na_2O 22 g./l. Na_2CO_3 as Na_2O 24.5 g./l. Na_2S as Na_2O	Approximately 15% solids The solids analyze 24.8% Na_2O			56 to 62% 327 cu. ft. 85%	38 to 44% 60 cu. ft. 15%

Those which show the lowest and highest rates on one basis show essentially the same behavior on the other basis.

There was no information contained in the questionnaires which would definitely establish a difference in corrosion quality between past and presently used steels for digester construction. By and large, most of the digesters have been constructed from A-70, A-285, and A-89 (ASTM Spec. No.) steels. The chemistry for these steels, as reported in the questionnaire, was very meager and not too informative. For the most part, they represented a typical analysis for the grade and not the analysis of the steel in the digester for which corrosion data were reported. In practically all cases, the contents of only such elements as C, Mn, P, and S were reported. ASTM specifications designate within certain limits the amounts of these four elements which may be contained in the steel plate in order to meet certain mechanical and physical requirements. Normal variation of these elements within the ASTM specification would not materially affect the corrosion behavior of the steel plate in most media. However, small variations of other elements, such as Cu, Si, Ni, O_2, Cr, etc., either alone or in combination, would affect corrosion behavior, in all probability. Such changes in the contents of these elements may result from changes in manufacturing and melting processes. Certain welding operations and procedures may produce welds sufficiently contaminated to lower corrosion resistance. In some work done by R. A. Huseby and M. A. Scheil (*Tappi* 34 (May, 1951)) and C. G. Von Essen (*Tappi* 33 (July, 1950)), the effects of some of these elements on the corrosion resistance of welded A-285 and A-212 stock are noted. The tests by Huseby and Scheil were conducted in a tumbling sulphate digester with the liquor used being 100% white liquor of high causticity and sulphidity. Their work indicated that silicon was detrimental to the corrosion resistance of either the weld or the base stock. From about 0.20 to 0.84% Si, the corrosion rate is directly proportional to the silicon content. In low-silicon (less than 0.10%), semikilled, or rimmed steels, a high oxygen content imparts additional corrosion resistance. When silicon is present in the steel (above 0.10%), the addition of less than 1% of Cr, Ni, or Cu has no effect on corrosion resistance. In the work by Von Essen, there was some indication that Ni- containing steels showed better corrosion resistance to digest liquors.

Analysis of All United States Mills Reporting Corrosion Data

In spite of the fact that there is some question with respect to the validity of the corrosion information submitted by most mills, all reported corrosion data were summarized.

The reported corrosion data for all United States digesters were arranged to show the per cent falling within a certain corrosion rate and service bracket. These data are shown in the table below.

Of the 68 kraft digesters put into service within the last 10 yr., 45.7% showed corrosion rates above 50 mils per yr. and 30.9% showed over 100 mils per yr. In the 11 to 20-yr. service bracket (81 digesters), only 9.9% showed rates above 50 mils and only 6.2% were over 100 mils. In the case of the 21 to 30-yr. service bracket, 100% were below 50 mils per yr. This suggests that corrosion rates are increasing, at least in the case of some mills. In the case of the soda digesters, no rates were reported above 50 mils per yr., with the largest percentage being in the 0 to 10-mil bracket. This seems to show that the soda operation is considerably less corrosive than the kraft.

The various types of linings or cladding which have been placed in service by certain mills covered by the questionnaires are included in Table VI, together with the corrosion information which is presently available. Types 316, 347, 304, and 410 stainless steels, and Inconel alloys have been employed as liners or cladding. The information contained in the questionnaires concerning the success of these types of lining was not sufficient to permit drawing any conclusions. This was particularly true in regard to corrosion behavior. Two mills report that their type 316 SS liners require repair within 1 yr. after installation because of cracking. Some of the linings were shop applied and some were field applied. The information obtained did not disclose which method was the more successful. Information on lining procedures should be sought since the prodedures employed may have an important bearing on both mechanical performance and corrosion behavior.

Linings of carbon brick have been reported installed in digesters with some success. However, some spalling was observed after 1 yr.'s service.

Canadian Mills

Analysis of the corrosion data reported in the Canadian questionnaire suggested the same trends as the United States analysis disclosed. However, this trend was based on only 28 digesters. (This was not the entire number of digesters with corrosion rates reported. One mill reported exactly the same rates for 28 digesters, so only one was considered.)

The corrosion data reported on the 28 Canadian digesters were arranged to show the per cent falling within a certain corrosion rate and service bracket. These data are shown below.

Service bracket, yr.	*Corrosion bracket, mils/yr.*						*No. of digesters*
	0–10	*11–30*	*31–50*	*51–70*	*71–100*	*Over 100*	
			Kraft Stationary and Rotary				
0–10	4.4%	7.4%	42.5%	7.4%	7.4%	30.9%	68
11–20	7.4%	53.1%	29.6%	2.5%	1.2%	6.2%	81
21–30	....	100 %	....	...	...	....	19
Over 30	....	....	....	...	...	....	..
			Soda				
Last 10	42.9%	....	57.1%	...	...	....	7
11–20	80.0%	....	20.0%	...	...	....	5
21–30	....	....	100 %	...	...	....	1
Over 30	66.7%	33.3%	....	...	...	....	3

Table IV. Analytical Data and Quantity of White and Black Liquor for the Two Canadian Mills

Questionnaire No.	*Analysis of white liquor*	*Analysis of black liquor*	*Quantity of white liquor used per cook*	*Quantity of black liquor used per cook*
59	3.7–5.0 lb./cu. ft. NaOH as Na_2O 1.6–2.0 lb./cu. ft. Na_2S as Na_2O 0.8–1.56 lb./cu. ft. Na_2CO_3 as Na_2O Sulphidity 25.0 to 34.0%	12–14° Bé.	500–750 cu. ft. white	600–1000 cu. ft. black
		Digesters 4N and 6N		
	4.34–4.8 NaOH 2.01–1.72 Na_2S Sulphidity 31.7 to 26.3%	12–14° Bé. 4% sulphur based on dry solids		
53	By differential titration 4.13 lb./cu. ft. NaOH as Na_2O 1.09 lb./cu. ft. Na_2CO_3 as Na_2O 1.60 lb./cu. ft. Na_2S as Na_2O Causticity 79.2% Sulphidity 23.5%	13.5° Bé. at 60F. 1.31 lb./cu. ft. Na_2S as Na_2O 0.05 lb./cu. ft. NaOH as Na_2O 1.32 lb./cu. ft. total as Na_2O Average total solids 2900–3000 lb./ton AD pulp	800 cu. ft.	700 cu. ft.

Table V. Corrosion Rates Based on Total Cooking Time—United States Digesters

Questionnaire No.	*Digester No.*	*Years of service*	*Total cooking time, yr.*	*Corrosion rate based on total service, in./yr.*	*Corrosion rate based on total cooking time, in./yr.*
38	1	10.0	6.0	0.006	0.010
	2	10.0	6.0	0.006	0.010
	3	5.3	3.2	0.011	0.019
	4	3.7	2.2	0.015	0.025
	5	2.2	1.3	0.009	0.015
41	1	13.3	7.6	0.036	0.063
	2	13.3	7.6	0.036	0.054
	3	13.3	7.6	0.047	0.082
	4	10.3	6.4	0.031	0.049
	5	10.3	6.4	0.021	0.034
	6	10.3	6.4	0.021	0.034
				Cone *Shell*	
17	1[a]	8.3	6.6	0.121 0.045	0.151
	2[a]	8.3	6.6	0.122 0.056	0.154
	1N[a]	3.5	3.0	0.262 0.274	0.315
	2N	5.5	4.8	0.175 0.134	0.198
	3N	5.5	4.8	0.180 0.131	0.202
	4N	5.5	4.8	0.160 0.145	0.177
	5N[a]	3.8	3.3	.. 0.256	0.291
44	1	16.0	14.4	0.006	0.007
	2	16.0	14.4	0.008	0.009
	6	14.3	13.0	0.020	0.021
9	1[a]	13.5	8.9	0.033	0.047
	2[a]	14.1	9.3	0.032	0.045
	3	14.2	9.4	0.029	0.040
	4	14.2	9.4	0.026	0.036
	5[a]	12.7	8.4	0.036	0.050
	6	13.2	8.7	0.031	0.044
	7	13.2	8.7	0.028	0.039
	8	13.2	8.7	0.031	0.044
	9[a]	12.2	8.0	0.039	0.058
	10	12.7	8.4	0.029	0.040
	11[a]	12.6	8.3	0.038	0.058
	12	12.7	8.4	0.027	0.037
	13	12.7	8.4	0.030	0.045
	14	7.7	5.1	0.039	0.049
	15	7.7	5.1	0.035	0.047
	16	7.7	5.1	0.023	0.035
	17	2.9	1.9	0.080	0.116
	18	2.0	1.3	0.050	0.077
	19	2.0	1.3	0.050	0.077
	20	2.0	1.3	0.095	0.146
7	1	2.5	2.2	0.045	0.061
	2	2.5	2.2	0.045	0.061
	3	8.5	7.6	0.045	0.058
	5	19.5	17.4	0.046	0.025
	6	19.5	17.4	0.037	0.042
	7	19.5	17.4	0.025	0.029
	8	11.5	10.2	0.029	0.034
	11	11.5	10.2	0.036	0.043
	12	11.5	10.2	0.039	0.046
	13	11.5	10.2	0.025	0.030
	14	11.5	10.2	0.037	0.044
	15	11.5	10.2	0.051	0.061
	16	11.5	10.2	0.058	0.069
	18	19.5	17.3	0.025	0.029
	19	19.5	17.3	0.036	0.041
	20	8.5	7.6	0.040	0.053
	21	8.5	7.6	0.040	0.053
	22	8.5	7.6	0.033	0.043
	23	2.5	2.2	0.042	0.057
	24	2.5	2.2	0.042	0.053

[a] Out of service.

Table VI. Types of Cladding and Lining Reported to be in Service

Questionnaire No.	*Type of operation*	*Type of digester*	*Type of cladding or lining*	*Reported corrosion rate, in./yr.*	*Years of service*
32	Kraft	Stationary	316SS ($^{7}/_{64}$ in.)	0.0[a]	1.0
22	Kraft	Stationary	347SS	0.006[a]	3.5
13	Kraft	Rotary	Inconel ($^{11}/_{64}$ in.)	0.063	...
25	Kraft	Stationary	316SS ($^{7}/_{64}$ in.)	....	2.0
26	Soda	Stationary	304SS ($^{1}/_{2}$ in.)	0.0	2.5
10	Kraft	Stationary	347SS ($^{1}/_{8}$ in.)	0.0	1.6
1	Kraft	Stationary	347SS ($^{7}/_{64}$ in.)	....	1.0
17	Kraft	Stationary	347SS ($^{7}/_{64}$ in.)	....	2.0
17	Kraft	Stationary	410SS ($^{13}/_{16}$ in.)	0.032	1.0
23	Kraft	Stationary	Brick (6.5 in.)	....	22.5
21	Kraft	Rotary	347SS ($^{7}/_{64}$ in.)	....	2.5
20	Kraft	Rotary	410SS	....	2.6
9	Kraft	Stationary	Carbon brick	....	0.1
44	Kraft	Stationary	Carbon brick	....	...
40	Kraft	Stationary	347SS ($^{7}/_{64}$ in.)	....	3.5
39	Kraft	Stationary	316SS ($^{7}/_{64}$ in.)	....	0.5

Note: Thickness of lining or cladding in parentheses.
[a] Liners replaced due to stress-corrosion cracking.

It can be seen that 74.0% of the digesters in operation during the past 10 yr. show rates above 50 mils per yr., while 85% of those in the 11 to 20-yr. bracket show rates below 50 mils per yr.

Comparison of the reported operational and processing data shows no major discrepancies between United States and Canadian mills.

GENERAL DISCUSSION

The analysis of the questionnaires has shown that a large percentage of mills contacted in the coverage had either very little or no corrosion information with respect to their digesters. Of the 492 digesters reported in the United States coverage, corrosion data were submitted on approximately 194, or 39.4%. In the case of the Canadian mills, 110 digesters were reported, of which corrosion information was submitted on 28 (25.3%).

Service bracket, yr.	*Corrosion bracket, mils/yr.* 0–10	11–30	31–50	51–70	71–100	Over 100	*No. of digesters*
			Kraft Stationary and Rotary				
0–10	...	12.5%	12.5%	25.0%	42.7%	6.3%	16
11–20	...	57.1%	28.6%	14.3%	....	...	7
21–30	...	100%	....	....	....	...	4
Over 30	100%	....	....	....	....	...	1

From the reported data on the digesters, it is indicated that industry-wide corrosion in the kraft operation is considerably more severe than in the soda, and in the kraft operation, the corrosion that has taken place during the past 10 yr. is more severe than that which occurred prior to this time. The data in the questionnaires failed to disclose a reason for this apparent increase in current corrosion rates in the kraft operation.

No correlation was disclosed between reported differences in corrosion rates for digesters and any reported "typical" chemical and/or physical differences in the pulping operation.

A more accurate appraisal of the seriousness of current corrosion problems could be made in the future if each mill in the industry at large would inaugurate a program of frequent (possibly every 6 months, but at least yearly) and regularly scheduled inspections of their digesters. It is necessary to obtain more adequate and accurate corrosion data than those which have been obtained by most mills in the past. Corrosion information should include a detailed description in regard to type and location of attack. Such data should be obtained in essentially the same manner and reported on the same basis. Data with respect to liquor analysis sulphidity, or any major variations in the pulping operation should be obtained and reported for the same period of time that corrosion information is secured. These data should also be reported on a standard basis.

A more complete and comprehensive chemical analysis of the metal used in the construction of samples from the digesters should be made. This would reveal considerably more information than routine analyses, which normally include only C, Mn, P, and Si.

In addition, a critical microscopic study of samples both from digesters giving good service and from those showing poor corrosion resistance should be made. Many times a microscopic examination of samples will reveal more information concerning the corrosion behavior of a given type of material than reported variations in the chemistry of the metal.

In addition to the above, fabrication and heat-treating data should be secured which relate directly to individual digesters.

In order to determine the most economical and practical methods of getting the necessary information, it may be desirable to select a few typical mills for extensive study before recommending industry-wide practices.

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Effect of Alum on Slime Formation in Board Mill Stock

WILLEM RUDOLFS and NELSON L. NEMEROW

Laboratory experiments on the effect of alum on slime formation and freeness of recirculated white water show that the Al^{+++} is mainly responsible for retardation and inhibition of slime growth in the absence of free mineral acidity. Adjustment of stock with acids to pH values of 4.9 has no effect on slime growth or decrease in freeness, but the pH range of 4.0 to 4.9 is somewhat critical and the acidity present causes slime formers to operate in an environment which is not necessarily their optimum. The degree of reduction in slime growth is dependent upon the quantities of alum added. In the presence of about 200 p.p.m. alum, no slime growth or decrease in freeness occurred.

In a previous article (*1*) the authors, on the basis of experiments, concluded that no slime growth resulted when the pH values of the white water were controlled to 4.5 with alum or sulphuric acid. Since the sulphate ion is common to both the alum and the sulphuric acid it would be possible that this ion was responsible for the inhibition of slime. It is also possible that the acidity of the liquid or that the aluminum ion was responsible for the retardation and inhibition of the slime. Because alum is so widely used in paper mills its specific effect on slime formation is of considerable importance.

The studies were divided into two general parts to determine: (1) the effect of temperature and alum concentrations on slime formation, and (2) the effect of alum, H_2SO_4, and HCl at constant temperature and constant pH values.

METHODS AND PROCEDURES

The apparatus for freeness determinations consists essentially of a 40-mesh wire screen supported between flanges in a pipe. The procedure used for freeness determinations was similar to that described previously (*1*) except that an aspirator was used to maintain a 2-in. vacuum on a mercury manometer instead of a vacuum pump and pressure gage. This method is considered more accurate.

Two series of experiments were conducted to provide minor variations and at the same time considerable duplication. To each of 12 paperboard white water samples (1 liter) were added 2.5 grams of dried paperboard. The new stock was disintegrated in a Waring Blendor for 30 sec. before being added to white water. The 12 samples were divided into four groups and incubated at 10, 20, 37, and 50°C. The three samples in each group were treated as follows:

	Alum, p.p.m.	*pH (resulting)*
(*a*)	0	6.4
(*b*)	104	5.7
(*c*)	202	5.0

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All 12 samples were incubated for 4 hr. at their respective temperatures, then poured onto the screen of the laboratory handsheet machine (*1*) and their initial drainage times recorded. The filtrates were recombined with their respective fiber mats from the screen and reincubated at their same temperatures until tested again. pH and freeness determinations were made five times during the 17 days of the experiment.

Series 2

Five grams of previously pulped and dried paperboard stock were added to four 1-liter samples of paperboard mill white water; one was used as a control; the other three were adjusted to a pH of 4.9 (a pH of 5.3 gave similar results) with alum, H_2SO_4, and HCl, respectively. All four samples were brought to a constant temperature of 20°C. and then poured onto the screen of the laboratory handsheet machine. Drainage times and pH values were recorded and the filtrates recombined with the fiber mat before the samples were reincubated at 20°C. This procedure was repeated at various times during the 28 days' test period.

EXPERIMENTAL RESULTS

Series 1

The effect of alum concentration in recirulated white water on slime formation is illustrated in Fig. 1. The white water slimed up and showed a corresponding decrease in freeness under the proper environmental conditions. Temperature and alum concentration were both important in the control of slime growth. For example, at 20°C. after 1 week, slime growth* occurred to such an extent that when no alum was added the freeness decreased (drainage time increased) 58.3%. However, under these same optimum slime conditions no growth or decrease in freeness occurred when 202 p.p.m. of alum were added. With an intermediate alum dosage (104 p.p.m.) the normal slime growth (as measured by freeness decrease) was inhibited about 50%. Likewise, when the temperature as increased above the optimum to 37°C. the slime growth decreased about 50%, whereas at a temperature of 50°C. slime growth was inhibited regardless of the alum concentration.

It should be noted that the pH of the white water as it came from the mill was 6.4 and that it contained 53 p.p.m. of ignited oxides (R_2O_3), most of which was aluminum. The quantity of aluminum present in the waste is important in determining the actual alum dosage necessary to inhibit slime growth.

The effect of alum in combination with changes in temperature on the time required before slime formations occurred varied materially. For instance, at 10°C. with no alum added to the original white water a maximum of 36.7% decrease in freeness resulted in

* Primarily capsulated bacteria.

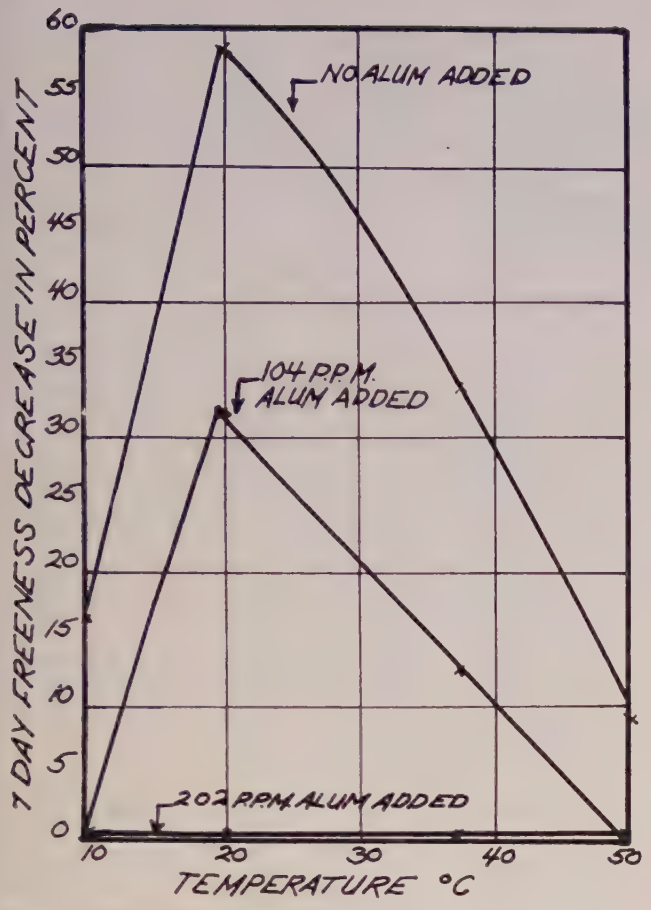

Fig. 1. Effect of alum concentration at various temperature on freeness

slime growth after 14 days, but with 104 and 202 p.p.m. alum added, no slime growth occurred during the 2-week test period. At 20°C. with no alum added a 58.3% decrease in freeness resulted after 7 days (60% in 14 days), but with alum addition no slime growth occurred in 14 days. At 37°C. with no alum 33% decrease in freeness resulted after 7 days, but no further decrease after 10 days. With 104 p.p.m. alum the slime growth at this temperature was depressed to 12.6% after 7 days and no decrease in freeness was observed after 10 days, whereas no slime occurred with 202 p.p.m. alum added. At a temperature of 50°C. no significant decrease in freeness was observed with or without alum additions.

The effect of alum concentration in white water on the changes of pH values during recirculation is illustrated in Fig. 2 for a constant temperature of 20°C. At a temperature of 20°C. slime growth is about at its maximum. The curves in Fig. 2 show that with no alum addition the pH value decreased from 6.4 to 5.8 in 3 days and thereafter gradually increased. With increasing alum additions the initial pH values were lower and did not reach as high pH values at the end of 14 days as with no alum additions. Since changes in pH value are the result of biological activities it is evident that biological activity was reduced by alum addition or that the total growth of organisms was reduced. Since the percentage freeness increased with alum additions it may be assumed that actual slime growth was reduced. At a temperature of 50°C. slime growth was depressed and the pH value did not drop below its original value regardless of the alum concentration present. It is clear, therefore, that either alum addition or maintaining the white water at 50°C. will prevent slime growth.

The question as to whether the effectiveness of alum was the direct result of the alum as a chemical agent or indirectly caused by the lowering of the redox potential of the white water system was not considered in this series of experiments. However, the effect of various concentrations of alum at pH values of 5.0 to 5.7 (when no free mineral acidity is present) on slime formation leaves some doubt regarding the importance of controlled pH values being the sole factor in preventing slime growth with alum.

Series 2

The experiments were designed to differentiate the effect of acid radicals of sulphuric and hydrochloric acid on slime formation in recirculated white water and the effect of the aluminum added. The white water samples were adjusted with H_2SO_4, HCl, and alum to the same pH value of 4.9. Hence, no free mineral acidity was present. Unadjusted "control" samples were used for comparisons. The effect of the added acids and alum on the decrease in freeness is illustrated in Fig. 3. The samples to which alum was added did not produce slime during 28 days, whereas the samples to which the mineral acids were added slimed up similarly to the control samples. In fact, the slime growth was so extensive in the H_2SO_4 and HCl adjusted samples that these samples decreased

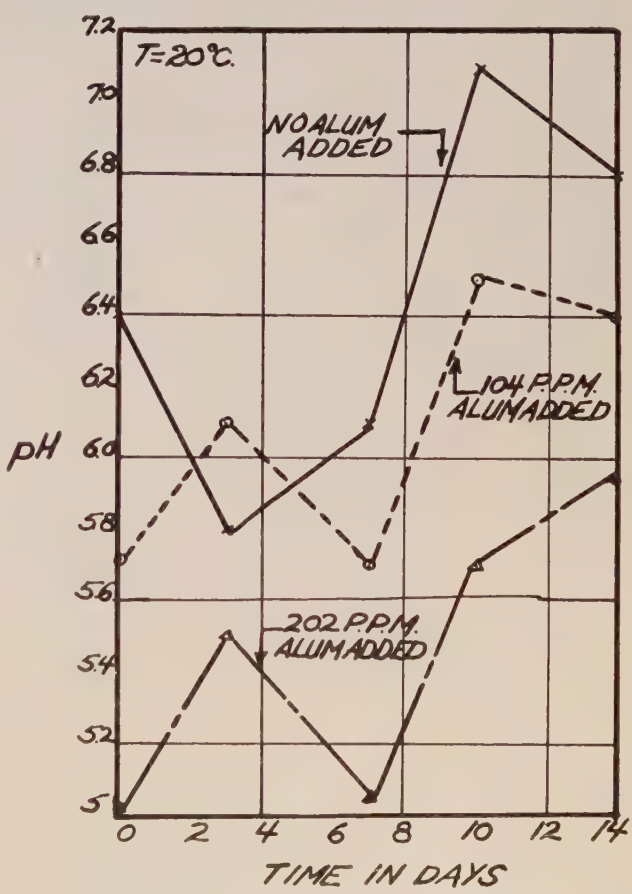

Fig. 2. Effect of alum concentration in white water on pH changes during recirculation at optimum temperature for slime growth

more than 160% in freeness (drainage rate) at the end of 28 days.

The characteristic drop and subsequent rise of pH values in uncontrolled white water occurred in the acid-adjusted samples (Fig. 4), indicating definite biological activity. In the alum-adjusted samples no continuous increase in pH values took place. It appears that alum in addition to contributing an acid radical which has some effect on retarding the optimum growth and multiplication of slime-forming microorganisms also either makes the food for slime-forming organisms unavailable or is sufficiently toxic to the slime-forming organisms to hinder their growth and multiplication. Addition of acids in concentrations insufficient to produce free mineral acidity in the white water does not have the same effect, but the presence of traces of free acid inhibits slime growth as well as alum. The degree of reduction in slime-forming organisms by alum depends upon the aluminum sulphate concentration present.

CONCLUSIONS

From the experimental results the following conclusions are drawn:

1. The optimum temperature for slime growth in recirculated white water appears to be about 20°C.
2. At a temperature of 50°C. slime growth is inhibited regardless of alum concentration or pH values of the white water.
3. Addition of about 200 p.p.m. alum prevented slime formation in recirculated white water, at its optimum temperature for growth, during a period of at least 30 days. Addition of 200 p.p.m. alum resulted in an initial pH of 5.0 of the white water containing about 50 p.p.m. R_2O_3.

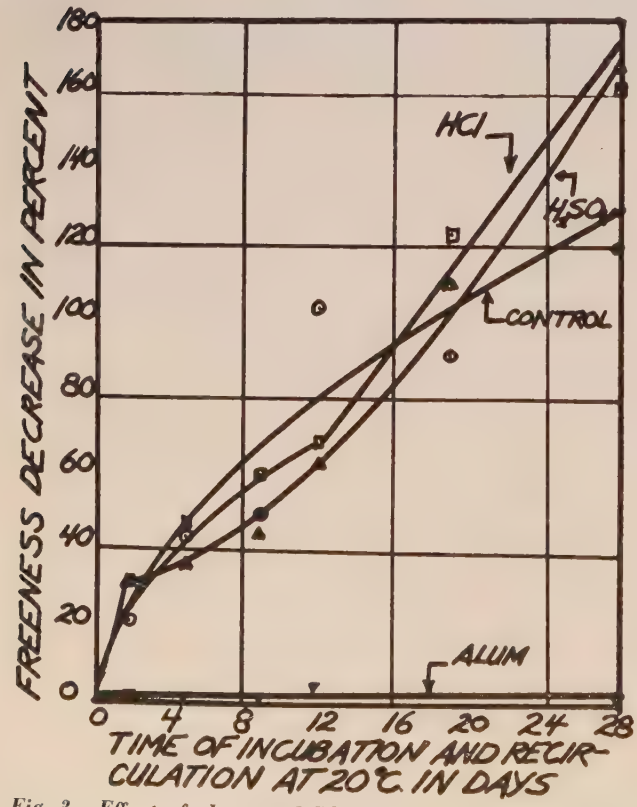

Fig. 3. Effect of alum and $SO_4^=$ and Cl^- on slime formation in recirculated white water

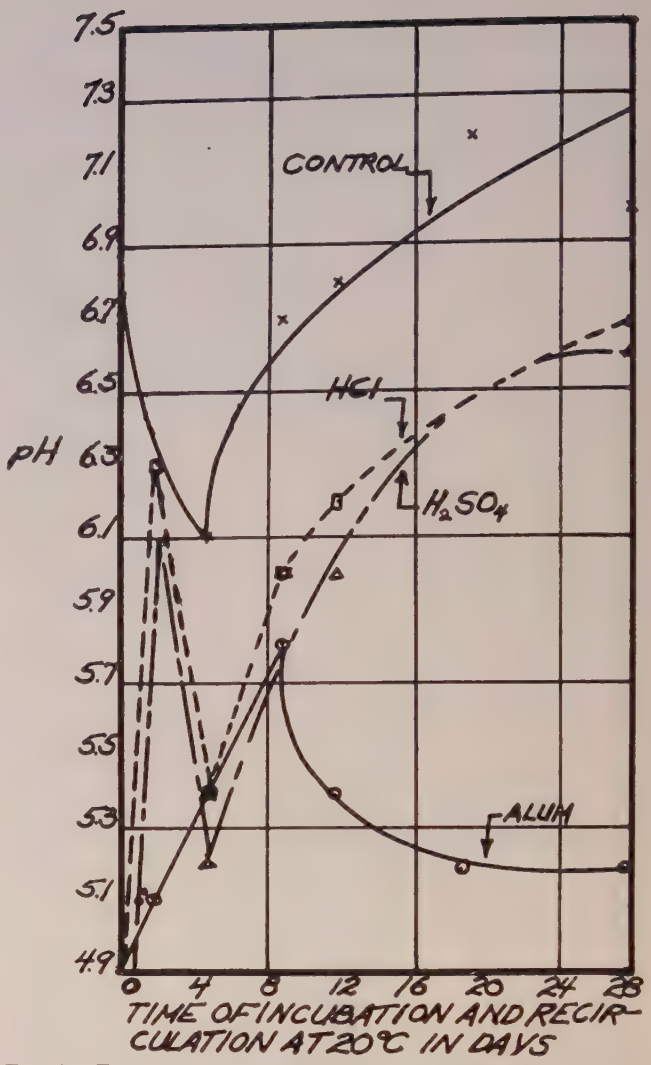

Fig. 4. Effect of alum as differentiated from $SO_4^=$ and Cl^- on pH changes in recirculated white water

4. Adjustment of pH values by H_2SO_4 or HCl to 4.9 did not affect slime formation.
5. At pH values above 4 both mineral acids and alum probably contribute to the recirculated white water acidity which hinders slime formation temporarily. Alum also contributes the Al^{+++} which further prevents slime multiplication by its toxicity or coagulating effects or both. Hence, alum in a certain minimum concentration (about 200 p.p.m.) is more effective in preventing slime growth than mineral acids at pH values above 4.
6. The presence of free mineral acids (pH values below 4.0) is as effective as alum for preventing slime growth and freeness decrease in recirculated white water.
7. The degree of slime prevention depends upon the quantity of alum present: the larger the amount of alum, the less growth and subsequent water freeness.
8. The quantity of alum to be added to a given white water for prevention of slime formation is related to the amount of alum present in the white water.

LITERATURE CITED

1. Rudolfs, Willem, and Nemerow, Nelson L., *Tappi* 33, No. 7: 321 (July, 1950).

Paper of the Journal Series, New Jersey Agricultural Experiment Station, Rutgers University, the State University of New Jersey, Department of Sanitation.

Case Studies in the Application of Industrial Statistics to Papermaking, II

CHARLES A. BICKING and RICHARD T. TRELFA

Two case studies are presented covering actual applications of statistical techniques to practical papermaking problems. The first case study explains the significance of control chart calculations on paper properties, presents a method for predicting over-all paper variability from these calculations, and outlines a procedure for evaluating the importance of the sources of variability. The second case study presents a general plan for designing an experiment. The general plan is applied to a specific paper mill experiment, and various possible experimental schemes are compared. A statistical appendix is included to give computations and more detailed discussions of some statistical procedures involved in the case studies.

Some applications of statistical techniques to papermaking have been previously discussed by the authors (*1*). Five case studies encompassed a variety of common paper mill problems. This paper is a continuation of the effort to provide information designed to help technical workers confronted with practical control problems. Two new case studies are presented.

CASE STUDY VI

Problem: Paper and paperboard vary in both cross-machine and machine directions. The causes of cross-machine direction variation may to some degree be independent of the causes of machine direction variation. Although control chart techniques are available for production control of properties in either direction (*1*), it is frequently desirable to express control chart limits in terms of variation to be expected among individual sheets of the product if the process is controlled. The problem is twofold:

1. Can variation of individual paper or paperboard sheets be predicted from control chart calculations assuming future production will be kept within control chart limits?
2. If predicted variation of individual sheets is excessive, should process changes be preferentially directed toward improvement of property in either machine direction or cross-machine direction?

Solution: A schematic representation of a typical quality control sampling plan and calculations is shown in Table I.

In Table I the X values represent the numerical level of the property measured (basis weight, caliper, porosity, etc.). The different positions (or different sheets) across the machine are represented by the letters $a, b \ldots n$. The sequence of sampling is represented by numbers $1, 2 \ldots k$. Sample ranges (R values) are the differences between the highest and lowest values in each sample. Sample averages ($\bar{X}$ values) are the arithmetic average of the individual X values in each sample. The moving ranges of sample averages (RM values) are the absolute differences between successive sample averages.

On examination of the system shown in Table I, it will be recognized that the individual tests at the different positions across the machine for each sample can be considered independent estimations of the sample property at these specific positions. Variation among these tests is an estimate of cross-machine variation. The test averages ($\bar{X}$ values) are estimations of the over-all sample property. For example, when basis weight is the test, the average estimates the basis weight which would be obtained through weighing a strip of paper across the full machine width. Variation among test averages is an estimate of machine direction variation plus effects of cross-machine variation (*2*).

In case study III (*1*), standard measures known as the "variance" and "standard deviation" (the square root of the variance) were used to estimate variablity (*3, 4*). These measures are of particular importance because the spread of a normal distribution curve (*1, 3*) may be readily described in terms of standard deviation units and because of the additive properties of variances. Direct calculation of these measures is laborious; therefore, they are frequently estimated through the use of ranges. $\bar{R}$ may be divided by a factor d_2 (*1, 5*) to give an estimate of cross-machine standard deviation. Similarly $\bar{R}M$ may be divided by the appropriate d_2 value to give an estimate which includes the machine direction standard deviation. Both estimates provide information about the process capabilities when the process is in a state of control. Further comments on this point and succeeding discussion are given in the Appendix, along with pertinent formulas and calculations.

Let the estimate of cross-machine standard deviation (based on $\bar{R}$) be represented by the symbol s_C and the estimate based on $\bar{R}M$ be represented by the symbol $s_{\bar{X}}$. Let σ_C' represent the true cross-machine standard deviation and let σ_M' represent the true machine direction standard deviation. Then (*2, 4*)

$$s_C^2 \text{ estimates } \sigma_C'^2 \tag{1}$$

$$s_{\bar{X}}^2 \text{ estimates } \sigma_M'^2 + \frac{\sigma_C'^2}{n} \tag{2}$$

$$n s_{\bar{X}}^2 \text{ estimates } n\sigma_M'^2 + \sigma_C'^2 \tag{2a}$$

Since variances are additive, the sum of the two estimated true variances $\sigma_C'^2$ and $\sigma_M'^2$ estimates the true variance $\sigma_X'^2$ which the individual X values would have

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Table I. Typical Procedure for Obtaining Control Chart Data for Paper or Paperboard Quality Control

Cross-machine position	*Machine direction position (samples in time sequence)* 1	2	3	.....	k − 1	k
a	X_{a1}	X_{a2}	X_{a3}	.....	$X_{a(k-1)}$	X_{ak}
b	X_{b1}	X_{b2}	X_{b3}	.....	$X_{b(k-1)}$	X_{bk}
...	...	...	...		...	...
...	...	...	...		...	...
...	...	...	...		...	...
n	X_{n1}	X_{n2}	X_{n3}	.....	$X_{n(k-1)}$	X_{nk}
Sample range	R_1	R_2	R_3	.....	$R_{(k-1)}$	R_k
Sample average	$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_3$	.....	$\bar{X}_{(k-1)}$	$\bar{X}_k$
Moving range of sample averages		RM_1	RM_2		$RM_{(k-1)}$	

Grand average $(\bar{\bar{X}}) = (\bar{X}_1 + \bar{X}_2 \ldots \bar{X}_k)/k$

Average sample range $(\bar{R}) = (R_1 + R_2 \ldots R_k)/k$

Average moving range of sample averages $(\bar{RM}) = (RM_1 + RM_2 \ldots RM_{(k-1)}/k - 1)$

if the process were operated within calculated control limits. The square root of this sum likewise estimates the true standard deviation of the individual X values (σ_X').

Since $\sigma_X'^2$ may be estimated by adding the estimates of $\sigma_C'^2$ and $\sigma_M'^2$, the following relationships can be readily derived from equations 1 and 2.

$$s_{\bar{X}}^2 + \frac{n-1}{n} s_C^2 \text{ estimates } \sigma_X'^2$$

$$\sqrt{s_{\bar{X}}^2 + \frac{n-1}{n} s_C^2} \text{ estimates } \sigma_X' \qquad (3)$$

With σ_X' estimated (the error of this estimate may also be calculated if desired (*2, 4*)), the expected variation of individual sheet properties (E_X) can be calculated as within plus or minus three σ_X' (standard deviation units) of the grand average $(\bar{\bar{X}})$ or :

$$E_X = \bar{\bar{X}} \pm 3\sigma_X' \qquad (5)$$

If the potential spread as calculated from equation 5 is too great, it is frequently desirable to determine whether machine direction or cross-machine direction process changes should be attempted.

Referring to equations 1 and 2a, it is apparent that if $\sigma_M'^2$ exists, then $ns_{\bar{X}}^2$ must be larger than s_C^2. The ratio $ns_{\bar{X}}^2/s_C^2$ (or the F ratio) has been discussed in case studies III and V (*1*), and the same technique is followed in determining if $ns_{\bar{X}}^2$ is significantly larger than s_C^2. If $ns_{\bar{X}}^2$ is significantly larger, $\sigma_M'^2$ may be calculated from equations 1 and 2a and compared to $\sigma_C'^2$. Process changes should first be directed toward minimizing the larger of the two. On the other hand, if both are of the same order of magnitude, or if $ns_{\bar{X}}^2$ is not significantly larger than s_C^2, process changes should be of a more general nature.

Results: (1) The variation in products to be expected if a process is controlled may be predicted. (2) If expected variation is excessive, process attention may be directed toward the most serious causes of that variation.

Example: The data of case study I (*1*) are repeated in Table II.

These data represent basis weight in pounds per thousand square feet obtained on each of five sheets across a 90-in. reel for 40 reels. The data were obtained before start of a quality control system. s_C as calculated from $\bar{R}$ (4.53) is 1.95. s_C^2 therefore is $(1.95)^2$ or 3.80. $s_{\bar{X}}$, calculated from $\bar{RM}$ (1.035) is 0.918; $s_{\bar{X}}^2$ is 0.843; and $ns_{\bar{X}}^2$ is 4.22. From equation 3, $\sigma_X'^2$ is 3.88. σ_X' is the square root of 3.88, or 1.97. From equation 5 it can be predicted that individual sheets of paper will be within ±5.9 lb. of the average basis weight if the process remains within control limits as calculated from $\bar{R}$ and $\bar{RM}$. Expected limits are from 44.9 to 56.7 lb. Actual count shows only two points (1%) outside these limits, so it can be concluded that the process was operated reasonably within control limits.

Since the control limits were not satisfactory, process changes were contemplated. However, the F ratio as calculated from $ns_{\bar{X}}^2/s_C^2$, i.e., 4.22/3.80, is 1.11, which is not significant. Changes of a general nature are therefore indicated to effect improvement. Such general changes were made and (as was illustrated in case study I) these changes were reflected in decreased variation in both cross-machine and machine directions.

CASE STUDY VII

Problem: How may an investigation on a paper or paperboard machine be preplanned to give maximum assurance of reliable and useful results with a minimum of experimentation?

Solution: In general an experimenter will proceed approximately as shown in Table III.

In designing an experiment on a paper or paperboard machine the engineer is confronted with many complexities. Evolution of an experiment designed to determine the effect of calender stack treatment on paperboard quality is presented to illustrate methods of coping with some of these complexities. Since this case study covers only the design of an experiment, it is assumed that the experimenter has already acquired the knowledge indicated in steps A and B of Table III.

When the statistical approach is used, the design of an investigation proceeds in three major parts: (1) a planning period (or possibly a conference of all interested parties (*8*)); (2) a preliminary design period; (3) a final design period.

The Planning Period

The propositions to be proved or tested must first be determined. Alternative outcomes of the program are then considered, as, for example, production of inferior or unsalable board, production of salable board at too high cost, and the like.

Factors to be studied are chosen, and the range through which they will be varied may be decided upon. End measurements are selected. Consideration is given to the possible importance of sampling variability, errors of test methods, and possible interrelationships (or interactions) among the factors. Time limitations, cost, man power, materials position, and the like may limit the number and scope of the runs possible.

In the example chosen for case study VII, add-on of material determines the cost of the treatment. However, the degree of penetration of the water box solution would be expected to affect the efficiency of the treatment at any add-on level. Add-on itself is affected by viscosity and concentration of the water box solution as well as by the properties of the board itself (such as moisture content, temperature, porosity, and the like). For any given material, concentration of water box solution can be readily varied and add-on can be varied independently over a fairly narrow range

by adjustments on board moisture content, water box location, number of water boxes, and the like. In compromise, concentration of calender treating solution, type of material, and dry add-on were chosen for study.

Paperboard is a nonuniform material and difficult to sample satisfactorily. Many test methods contribute appreciable variability to results. In the example presented it is also likely that concentration effects will be more marked for one material than the other and that add-on will vary with material type, resulting in what is known as "interaction."

Preliminary Design Period

During the preliminary design period a systematic schedule of the experimental runs is prepared. Plans are made to eliminate or minimize the effect of extraneous variables by randomization, control, balancing out, special sampling, and the like. Statistical methods to be used in analyzing results are selected and plans are laid for the orderly accumulation of data.

The principal requirements of a design are to keep to a minimum the number of experimental runs, to get as precise a comparison as possible of the effect of changing levels of the factors, to uncover any interactions that exist and, if it is not independently determined, to measure the experimental "error" or the variability introduced by the inability to reproduce exactly any particular result. Classical, Latin square, and factorial designs as used in studying calender stack treatment will be explained and tables will illustrate how each meets the main requirements.

The time-honored method of changing one factor at a time is often referred to as the "classical design" and involves, for the example, four runs with the combinations of concentration, dry add-on, and type of material at a standard level and at a trial level of the factor shown in (Table IV). It is customary to make the first run at the standard level of each of the factors as a basis of comparison. In subsequent runs each of the factors in turn is varied to its trial level while the other two factors are kept at their standard levels. As a result, comparisons between C_1 and C_2, between A_1 and A_2, and between M_1 and M_2, are made on the basis of one result each. (Note that in much paper testing the one result may represent an average of several tests on aliquot samples made during the same run.) Furthermore, unless independent information is available or each run is repeated, no information is given on experimental error. The lack of a measurement of error makes it impossible to determine whether an observed difference is large enough to be significant. Also, no information is given on the interactions of the factors because they have been varied one at a time.

The second-simplest form of design, perhaps, is the "Latin square." The Latin square minimizes the

Table II. Basis Weight of Paperboard Before Start of Quality Control System

Pounds per 1000 Sq. Ft.

Reel No.	*Front*	*Front middle*	*Middle*	*Back middle*	*Back*	*Reel average*	*Reel range*	*Moving range of reel averages*
1	56	49	56	52	55	53.6	7	...
2	53	49	53	49	54	51.6	5	2.0
3	51	49	52	51	55	51.6	6	0.0
4	61	50	51	55	55	54.4	11	2.8
5	55	50	51	48	52	51.2	7	3.2
6	48	52	51	49	54	50.8	6	0.4
7	53	50	48	49	53	50.6	5	0.2
8	53	51	53	50	51	51.6	3	1.0
9	54	54	49	52	52	52.2	5	0.6
10	52	51	49	49	52	50.6	3	1.6
11	48	52	49	48	51	49.6	4	1.0
12	50	48	49	50	48	49.0	2	0.6
13	48	48	48	48	49	48.2	1	0.8
14	51	48	50	47	50	49.2	4	1.0
15	46	47	51	45	49	47.6	6	1.6
16	53	51	49	47	48	49.6	6	2.0
17	52	49	48	51	49	49.8	4	0.2
18	52	51	50	49	51	50.6	3	0.8
19	53	49	50	47	51	50.0	6	0.6
20	52	51	48	47	51	49.8	5	0.2
21	53	48	50	50	50	50.2	5	0.4
22	50	50	49	48	53	50.0	5	0.2
23	48	52	50	49	51	50.0	4	0.0
24	50	51	49	47	50	49.4	4	0.6
25	51	48	50	51	50	50.0	3	0.6
26	50	51	49	48	51	49.8	3	0.2
27	50	48	47	49	50	48.8	3	1.0
28	53	52	50	49	50	50.8	4	2.0
29	53	53	50	50	54	52.0	4	1.2
30	53	54	53	50	54	52.8	4	0.8
31	54	51	54	54	54	53.4	3	0.6
32	55	58	56	51	56	55.2	7	1.8
33	53	55	54	49	53	52.8	6	2.6
34	52	53	54	48	52	51.8	5	1.0
35	52	52	50	48	51	50.6	4	1.2
36	51	52	49	49	52	50.6	3	0.0
37	49	52	49	50	50	50.0	3	0.6
38	52	55	53	50	53	52.6	5	2.6
39	50	52	52	49	49	50.4	3	2.2
40	47	51	51	48	49	49.2	4	1.2
					Totals	2032.0	181	41.4
					Averages	50.8	4.53	1.035

Table III. Procedure for Experimenter

A.	Obtain a thorough understanding of the purpose of the experiment
B.	Become familiar with the process or processes involved
C.	Design the experiment
D.	Carry out the experiment
E.	Analyze the data
F.	Interpret the data
G.	Design further experiments or terminate the project

number of runs and therefore has some shortcomings. A Latin square arrangement for the sample program is given in Table V. Involving the same number of runs as the classical design, the Latin square has an outstanding advantage in that comparisons between standard and trial levels of each of the factors may be made on the basis of averages of two results each. The averages of the two columns are used for comparing C_1 and C_2, of the two rows for A_1 and A_2, and of the two diagonals for N_1 and M_2. The order in which the runs are made is normally randomized. The data are then organized as in Table V for ease in computation.

Although larger Latin squares will provide a measure of the experimental error, the design shown does not. No Latin square uncovers interactions and in this respect Latin squares are no better than classical designs. However, small Latin squares are particularly valuable if an independent measurement of the experimental error is available. They may be used very effectively to screen out the most important factors among a large number under investigation. These important factors may then be grouped in a design that can separate effects of interactions.

The third method of designing an experiment is called a "factorial design." This design maximizes the amount of information from a given number of runs and is most suitable for statistical analyses. It involves simply making a series of runs with each level of every factor in all possible combinations. Although for large experiments this may involve an unmanageable number of runs, a variety of useful techniques is available for reducing the number of runs without sacrificing essential information (*4*, *9*), The full factorial design for the calender stack treatment is given in Table VI. Sequence of runs is normally randomized, with results tabulated in several ways depending on the information desired.

It is possible under the plan of Table VI to make simple comparisons between averages of four tests each; for example, the average of all four runs under C_1 is compared to all four under C_2. The method of statistical analysis used, called "analysis of variance," separates effects of experimental error and of interactions among the factors.

It may be noted that the Latin square is in effect one half of the factorial design. The effect of cutting the experiment in half, in this instance, is to lose all information on experimental error and on interactions

Table IV. Classical Design for Investigating Calender Stack Treatment

	Concentration	*Dry add-on*	*Type of material*
Run 1	C_1	A_1	M_1
Run 2	C_2	A_1	M_1
Run 3	C_1	A_2	M_1
Run 4	C_1	A_1	M_2

Subscripts: 1 represents a standard level; 2 represents a trial level.

Table V. Latin Square Design for Investigating Calender Stack Treatment

	C_1	C_2
A_1	M_1	M_2
A_2	M_2	M_1

Run 1	C_1	A_1	M_1
Run 2	C_1	A_2	M_2
Run 3	C_2	A_1	M_2
Run 4	C_2	A_2	M_1

Subscripts: 1 represents a standard level; 2 represents a trial level.

and to reduce the precision of comparison. For larger factorial designs partial performance does not have so stringent an effect. If the classical experiment is repeated, the same number of runs are required as in the factorial design. However, because of the inherent faults in the classical approach, accuracy of comparison is much reduced and interaction effects are still unobtainable.

Table VII provides a comparison of the results to be expected from experiments carried out with these designs. The advantages of the factorial design are readily apparent from Table VII and will not be discussed further.

Final Design Period

During the final design period the minimum designs developed in the preliminary design period are further modified. Replications may be included; additional levels of some factors may be added to permit correlation studies. Sequence of runs may be randomized, and in some cases steps may be taken to permit evaluation of runs through analysis of average changes in property level from run to run, rather than through analysis of the absolute properties measured.

In the water box treatment, for example, the runs were randomized and replicated; furthermore, to minimize the effect of known board property cycles, provisions were made to correct experimental results for these cycles through making a number of short runs and by alternating standard treatments between experimental runs.

These measures permitted differences in property level to be used as criteria of quality, and allowed multiple replication in a practical time period.

Results: (1) Through a statistically designed experiment, the basis is laid for obtaining maximum in-

Table VI. Factorial Design for Investigating Calender Stack Treatment

	C_1		C_2	
	A_1	A_2	A_1	A_2
M_1	Run 1	2	3	4
M_2	5	6	7	8

Run 1	C_1	A^5	M_1
Run 2	C_1	A_2	M_1
Run 3	C_2	A_1	M_1
Run 4	C_2	A_2	M_1
Run 5	C_1	A_1	M_2
Run 6	C_1	A_2	M_2
Run 7	C_2	A_1	M_2
Run 8	C_2	A_2	M_2

Subscripts: 1 represents a standard level; 2 represents a trial level.

Table VII. Effect of Experimental Design on Results Obtained

Three Factors, Two Levels Each

Type of design	*Runs required*	*Tests averaged for comparison*	*Experimental error measured*	*Interaction measured*
Classical	4	1	No	No
Latin-square	4	2	No	No
Factorial	8	4	Yes	Yes
Classical (repeated)	8	2	Yes	No

formation with minimum experimentation. (2) Through knowledge of the paper process and application of statistical thinking, the experiment may be modified to give a high degree of assurance in the results, regardless of the state of control of the process.

LITERATURE CITED

1. Bicking, C. A., and Trelfa, R. T., *Tappi* 34, No. 8: 370–380 (Aug., 1951).
2. Davies, Owen L., "Statistical Methods in Research and Production," 2nd ed. revised, London, England, Oliver and Boyd, 1949.
3. "ASTM Manual on Quality Control of Materials," Special Technical Publication 15-C, Philadelphia, Pa., American Society for Testing Materials, Jan., 1951.
4. Brownlee, K. A., "Industrial Experimentation," 3rd American ed. (4th British ed.), Brooklyn, N. Y., Chemical Publishing Co., 1949.
5. American Standards Association, American War Standards, Z1.1-1941, Z1.2-1941, Z1.3-1942, New York, N. Y., American Standards Association, May, 1941, April, 1942.
6. Bicking, C. A., and Trelfa, R. T., unpublished reports, Hercules Powder Co.
7. Fisher, R. A., and Yates, F., "Statistical Tables," 3rd ed. revised, New York, N. Y., Hafner Publishing Co., 1948.
8. Old, Bruce S., *The Scientific Monthly* 63: 129–134 (Aug. 1946).
9. Cochran, W. G., and Cox, G. M., "Experimental Designs," New York, N. Y., John Wiley & Sons, Inc., 1950.

APPENDIX

Case Study VI

A. Use of $\bar{R}$ and $\bar{R}M$ for Control Chart Calculations

To comprehend fully the meaning of control chart limits it must be recognized that (1) paper mill data are obtained in a nonrandom or biased manner and (2) behavior of process over a large number of short periods is used to predict performance possible over long periods. (This is based on the knowledge that even an uncontrolled process will tend to behave in a controlled manner for any given short period.) Thus control limits measure potential process variation and not actual process variation unless the process is controlled.

For a paper or paperborard process the control chart techniques do not generally at first give reliable estimates of process capabilities because (1) process variation generally occurs in both long-term and short-term cycles, (2) samples represent too small a proportion of total process output, and (3) time interval between samples is too long to qualify as a "short" period since it can be shown (*6*) that pronounced cycling normally does exist, even within any 1 min. of operation

For these reasons, calculations by control chart techniques usually include a considerable number of extraneous effects when applied to the paper or paperboard process, and investigative work is a necessary prerequisite to establishment of true control limits.

Although the control chart techniques do include some extraneous effects, the control chart is valuable in (1) identifying long-term cycles, (2) detecting unusual process variations, and (3) evaluating the effect of some process changes.

The above comments primarily serve to emphasize that statistical techniques can be of maximum value only if applied with a thorough understanding of both the techniques and the process. *Blind use of most statistical techniques may lead to highly erroneous conclusions.*

Control chart calculations are as follows:

$$s_C = \frac{\bar{R}}{\bar{d}_2} \qquad s_C^2 = \left(\frac{\bar{R}}{\bar{d}_2}\right)^2 \tag{1}$$

$$s_{\bar{X}} = \frac{\bar{R}M}{d_2} \qquad s_{\bar{X}}^2 = \left(\frac{\bar{R}M}{d_2}\right)^2 \tag{2}$$

The factor d_2 may be found in Table B_2, Supplement B in the ASTM Manual on Quality Control of Materials (*3*).

B. Analysis of Variance from Control Chart Calculations

Variation in the X values of Table I can be considered as caused by a combination of machine direction and cross-machine direction effects. (Other breakdowns of variation can and should be made to portray the picture more accurately.) If $\sigma_C'^2$ represents the true variance (variation) due to cross-machine direction effects and $\sigma_M'^2$ represents the true variance due to machine direction effects, the true variance of a universe of X values will be $\sigma_C'^2 + \sigma_M'^2$. The variance of $\bar{X}$ values would then be $\sigma_M'^2 + \sigma_C'^2/n$. As a limit if each sample was assessed on an infinite number of tests, the second term would vanish and the variance of $\bar{X}$ values would equal the true variance due to machine direction effects. If $\sigma_{\bar{X}}'^2$ represents the true variance of the universe of $\bar{X}$ values:

$$\sigma_{\bar{X}}'^2 = \sigma_M'^2 + \frac{\sigma_C'^2}{n} \tag{3}$$

or, multiplying by n

$$n\sigma_{\bar{X}}'^2 = n\sigma_M'^2 + \sigma_C'^2 \tag{4}$$

$\sigma_X'^2$, $\sigma_C'^2$ and $\sigma_M'^2$ cannot be determined exactly but can be estimated.

A variance s_C^2 can be obtained from $\bar{R}$ (equation 1) and a variance $s_{\bar{X}}^2$ can be estimated from $\bar{R}M$ (equation 2). Using an arrow to denote "is an estimate of"

$$s_C^2 \rightarrow \sigma_C'^2 \tag{5}$$

$$s_{\bar{X}}^2 \rightarrow \sigma_{\bar{X}}'^2 \rightarrow \sigma_M'^2 + \frac{\sigma_C'^2}{n} \tag{6}$$

$$ns_{\bar{X}}^2 \rightarrow n\sigma_M'^2 + \sigma_C'^2 \tag{6a}$$

$$s_{\bar{X}}^2 - \frac{\sigma_C'^2}{n} \rightarrow \sigma_M'^2 \tag{6b}$$

It should be pointed out that the additive properties of "sums of squares" and "degrees of freedom" as covered in analysis of variance discussions should not be confused with the additive law of the combined effect of several independent variances. The former are governed by algebraic identities and *must apply* to any arithmetically correct calculations, while the latter is a property of "true" variances of infinite universes and is never completely realized by practical

estimates of variances (*2*). Therefore, these estimates should be used only when the number of samples taken, k, is large.

To test whether $\sigma_{M'}{}^2$ exists independently of $\sigma_{C'}{}^2$ first postulate that $\sigma_{M'}{}^2$ does not exist and that all X values are from the same universe (null hypothesis). Equation 6a then becomes:

$$ns_{\bar{X}}{}^2 \rightarrow \sigma_{C'}{}^2 \qquad (6c)$$

$s_C{}^2$ and $ns_{\bar{X}}{}^2$ are then independent estimates of $\sigma_{C'}{}^2$. The errors of these estimates depend only on their degrees of freedom, and the significance of the difference between them is tested by the F ratio using k degrees of freedom (where k is large) for $ns_{\bar{X}}{}^2$, and $k(n-1)$ degrees of freedom for $s_C{}^2$. If $ns_{\bar{X}}{}^2$ is significantly greater than $s_C{}^2$, the difference cannot reasonably be explained as due to chance and the null hypothesis is discarded.

Although the preceding calculations are important in determining the importance of sources of variation, the variation of the population X values may be estimated directly from $s_C{}^2$ and $s_{\bar{X}}{}^2$, whether or not $\sigma_{M'}{}^2$ exists.

If $\sigma_{X'}{}^2$ represents the true variance of the universe of X values

$$\sigma_{X'}{}^2 = \sigma_{M'}{}^2 + \sigma_{C'}{}^2 \qquad (7)$$

Therefore, from this equation and equations 5 and 6 it is apparent that:

$$s_{\bar{X}}{}^2 + \frac{(n-1)s_C{}^2}{n} \rightarrow \sigma_{X'}{}^2 \qquad (8)$$

If $\sigma_{M'}{}^2$ exists, equation 8, when solved, becomes

$$\sigma_{M'}{}^2 + \sigma_{C'}{}^2 \rightarrow \sigma_{X'}{}^2 \qquad (9)$$

If $\sigma_{M'}{}^2$ does not exist, equation 8, when solved, becomes

$$\sigma_{C'}{}^2 \rightarrow \sigma_{X'}{}^2 \qquad (10)$$

C. Calculations for example of Case Study VI

From Table II:

$\bar{\bar{X}} = 50.8$ $\quad n = 5$
$\bar{R} = 4.53$ $\quad k = 40$
$\bar{R}M = 1.035$

From ASTM Manual on Quality Control (*3*) Supplement B, Table B2:

$\frac{1}{d_2}$ for $\bar{R}M$ (subgroups of 2) $= 0.8865$

$\frac{1}{d_2}$ for $\bar{R}$ (subgroups of 5) $= 0.4299$

$s_C = 4.53 \times 0.4299 = 1.95$

$s_C{}^2 = (1.95)^2 = 3.80$

$s_{\bar{X}} = 1.035 \times 0.8865 = 0.918$

$s_{\bar{X}}{}^2 = (0.918)^2 = 0.84$

$ns_{\bar{X}}{}^2 = 5 \times 0.843 = 4.22$

$\sigma_{X'}{}^2 = 0.84 + \frac{4}{5}(3.80) = 0.84 + 3.04 = 3.88$

$\sigma_{X'} = \sqrt{3.88} = 1.97$

Expected variation of individual sheets is

$$50.8 \text{ lb.} \pm 3 \times 1.97 = 50.8 \text{ lb.} \pm 4.9 \text{ lb.}$$

$F = \frac{4.22}{3.80} = 1.11$ with degrees of freedom $k(n-1) = 160$ and $k = 40$

From published data (*2*, *7*) it is found that F is not significant.

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The Determination of Starch in Paper

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The colorimetric determination of starch in paper through application of the starch-iodine reaction represents a quick and precise method. The detailed procedure is given.

The chief problem in determining starch in paper is the differentiation of starch from other polysaccharides. In many methods the separation is based upon the selective removal of starch by dilute acetic acid (*1*, *2*) or by enzymes (*3*, *4*). The solubilized starch is then removed from the paper pulp by filtration and is further hydrolyzed to glucose, the amount of which is determined from the reducing value. These methods are time consuming and tedious at best. Moreover, the accuracy obtainable is dependent upon the complete insolubility of the pulp polysaccharides during the acid or enzyme treatments. Brobst and Langlois (*4*) have stated that the nonstarch polysaccharides cause no error in their method using malt amylase, but they did not report having applied the method to papermaking pulps separately. In our experience, appreciable "blanks" are obtained on most starch-free papermaking pulps by the use of the TAPPI Standard (*3*) and it does not appear possible to eliminate this interference entirely because a considerable quantity of reducing materials is obtained from many pulps by water extraction alone.

The application of the blue starch-iodine complex for both qualitative and quantitative purposes is very old. Nevertheless, the colorimetric quantitative procedure still is not used in many instances where it has advantages over the reducing sugar method. The colorimetric method is not affected by other polysaccharides which are present in ordinary papermaking pulps, and it represents a quick and simple test. The chief limitation in accuracy is the difference in color produced by various types of starch. This difficulty is not too serious over the range of starches commonly used in papermaking, and it is entirely obviated if the starch used in the paper is available separately for standardization.

A number of factors in the colorimetric method for starch were studied by Simerl and Browning (*5*). In

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further applications of the method attention has been given to means for completely extracting the starch from the paper, because starch cannot be removed from paper quantitatively with hot water. It is known that strong mineral acids dissolve starch and, after a number of preliminary experiments had shown its effectiveness, hydrochloric acid was chosen for use in the analysis of paper.

The requirements of the acid treatment are that the starch be dissolved completely and that one avoids hydrolysis of the starch to the extent that the iodine color reaction no longer occurs. It has been found advisable to extract the major portion of the starch with hot water. This is followed by two short extractions with approximately 20% hydrochloric acid and one similar extraction with concentrated hydrochloric acid at room temperature. In order to avoid further hydrolysis, the filtrate after each treatment is collected in the same flask so that the stronger acids are immediately diluted.

The recommended method given below has been found precise and quick, and it has been applied for a considerable number of analyses with satisfactory results. Illustrative analyses on two commercial papers, including a comparison with TAPPI Standard T 419 m, are given in Table I. It is usually found that the

Table I. Analysis of Two Papers for Starch

	Tub-sized paper, % starch	*Beater-sized paper, % starch*
Colorimetric method	3.87	2.52
	3.85	2.49
	3.85	2.50
	3.76	2.48
	3.79	2.50
Mean	3.82	2.50
Standard deviation (s)	0.05	0.02
TAPPI Standard T 419 m	4.10	2.83
	3.94	2.60
Mean	4.02	2.72

TAPPI method gives slightly higher results than the colorimetric method because of sugars derived from the pulp.

COLORIMETRIC METHOD FOR STARCH IN PAPER

It is convenient to use paper which has been cut into 0.25-inch squares. Weigh out 0.25 to 0.50 gram (depending on the amount of starch present). Transfer to a 150-ml. beaker, add 100 ml. of hot water, and heat in a boiling water bath for 15 minutes. Macerate the paper frequently with a glass rod during this period. Decant the liquid through a coarse porosity fritted-glass crucible with an asbestos mat, retaining as much as possible of the paper in the beaker. Wash the paper once with hot water and pass the water through the filter.

Add 25 ml. of 1:1 hydrochloric acid at room temperature to the paper in the beaker and let stand with gentle maceration for exactly 2 minutes. Filter through the crucible previously used and receive the filtrate in the flask containing the water extract. Repeat the extraction with dilute acid. Finally, add 25 ml. of concentrated hydrochloric acid to the paper in the beaker and let stand for exactly 20 seconds. Filter immediately, transfer the paper to the crucible with wash water, and wash the paper with about 200 ml. of hot water.

At this point the paper may be tested for complete removal of starch by adding a few drops of very dilute iodine solution to the mat of fibers in the crucible. Normally, no color will be observed. Even a trace of residual starch will be evident from the appearance of the blue color.

Cool the filtrate to about 20°C., transfer to a 500-ml. volumetric flask, add 12.5 ml. of iodine reagent, and dilute to the mark. Determine the transmission or optical density with a suitable colorimeter. In the present work, the optical density was determined with a Beckman quartz spectrophotometer at 580 mmu. Any of the commercially available instruments for colorimetric analysis should prove equally suitable. The reference cell contains a standard iodine solution as described in the Calibration Procedure. The amount of starch is ascertained by reference to a predetermined calibration curve.

The iodine reagent contains 15 grams of potassium iodide and 10 grams of iodine, diluted with distilled water to exactly 1 liter.

PREPARATION OF THE CALIBRATION CURVE

If possible, the same starch which is present in the paper should be used, otherwise one of a similar type should be chosen. Weigh accurately an amount equivalent to 0.1 gram of oven-dry starch and transfer it to a 150-ml. beaker. Add 100 ml. of distilled water and heat in a boiling water bath with frequent stirring for 15 minutes. Transfer the solution to a 500-ml. volumetric flask, cool to about 20°C., dilute to the mark with distilled water, and mix thoroughly.

Pipet out aliquots of this stock solution containing from 2 to 20 mg. of starch (1 ml. of solution contains 0.2 mg. of starch), and transfer to 150-ml. beakers. Add about 0.25 gram of alpha pulp or purified cotton linters and enough distilled water to make approximately 100 ml. The addition of the pulp at this point is necessary to obtain complete solution of the starch; if this step is omitted, some granules will not be completely dispersed.

Treat the solutions in the beakers exactly according to the procedure for paper; that is, the pulp or linters is extracted successively with hot water, 1:1 hydrochloric acid, and concentrated hydrochloric acid. Transfer the extracts and washings to a 500-ml. volumetric flask, dilute to about 475 ml., and add 12.5 ml. of the iodine reagent. Dilute to the mark and mix. The optical density should be determined within 3 to 4 minutes after the iodine reagent is added. Some unmodified starches are precipitated on longer standing.

The reference cell is filled with a solution which contains the same amounts of acid and water that are used in the analysis. The required amount of acid is diluted to about 475 ml. in a 500-ml. volumetric flask, 12.5 ml. of iodine reagent are added, and the flask is filled to the mark. A new reference solution should be prepared each day. The reference solution should be replaced in the reference cell for every test, although it will not change in transmission over a period of about 2 hours if kept covered while in the spectrometer.

The results of a number of calibrations have shown that the optical density plotted against starch concen-

trations gives a linear relationship over the range of 2 to 20 mg. of starch.

LITERATURE CITED

1. Voorhees, V., and Kamm, O., *Paper* 24, No. 25: 15–19 (Aug. 27, 1919).
2. Dijk, J. W., *Chem. Weekblad* 38: 329–330 (1941).
3. TAPPI Standard T 419 m-45.
4. Brobst, K. M., and Langlois, D. P., *Tappi* 34: 238–240 (1951).
5. Simerl, L. E., and Browning, B. L., *Ind. Eng. Chem., Anal. Ed.* 11: 125–128 (1939).

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Particle Size of Clay, Its Determination and Effects

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The chief purpose of this paper is to discuss the properties of the clay fractions in relationship to the coating of paper. The method used for separating the fractions is described, but is incidental to the main purpose.

Over a considerable period of time in the operation of our off-the-machine coating mill, variations were noted in the coating characteristics of both domestic and English clays for which neither the suppliers nor ourselves had any logical explanation. For example, a high-grade domestic clay suddenly produced dusting on the calenders which lasted for several weeks until another grade of clay was substituted. From time to time a high grade of English coating clay varied considerably in its running qualities and its behavior in the coating mix. The suppliers gave particle size data in the range 10 down to 2 mu in support of their contention that the quality of clay had not changed. However, since between 80 and 90% of the clay is under 2 mu, it was believed that the variations were probably due to changes in the fraction below 2 mu. It was decided to study this problem by extending the range of particle size measurements into the under 2-mu fraction, and by studying the clay slips of the fractions with the Hercules Hi-Shear Viscometer. It was found that clays with almost identical particle size distribution above 2 mu might have entirely different properties when used in coating color. The Interchemical Laboratories found the same thing to be true in their work with the Green viscometer. Pigments which had identical analyses had very different rheological properties dependent on the fraction under 2 mu. Green showed with a microscope that the differences in behavior between their pigment samples depended very largely on the particle size distribution in this low range.

There are a number of very excellent methods of determining particle sizes in the clay range. These methods are sedimentation (*1*), beaker type centrifuge (*2, 3*), long arm centrifuge (*4*), and microscopic analysis Although these methods will give analyses down to one-twentieth micron, they are very time consuming, too much so for routine control work in the average laboratory. It was for this reason that a shortened method for determining particle size in the under 2-mu range was very desirable.

The basic equation which was used for the work was that developed by Svedburg (*5*), who obtained this by equating friction force of a falling particle as expressed by Stokes' law to the net centrifugal force:

$$6\pi R\eta \frac{dx}{dt} = \frac{4}{3}\pi R^3(\rho - \rho_0)\theta^2 x \qquad (1)$$

where

R = the radius of the particle in centimeters
x = the distance from the center to the point from which the particle begins to move (the point of average centrifugal force)
dx = the distance in centimeters the particle falls in time
dt = seconds
ρ = density of the particle in grams per cc.
ρ_0 = density of the medium
η = viscosity in poises
θ = angular velocity in radians per second

Rearranging and integrating equation (1)

$$\int_{x_1}^{x_2} \frac{dx}{x} = \int_0^t \frac{2}{9}\left(\frac{R^2(\rho - \rho_0)\theta^2}{\eta}\right) dt \qquad (2)$$

$$\ln\left(\frac{x_2}{x_1} = \frac{2R^2(\rho - \rho_0)\theta^2 t}{9\eta}\right) \qquad (3)$$

where

x_2 = the distance from the center to the end of the tube
x_1 = the distance from the center to the meniscus of the liquid

If x is zero, then θ is zero and so the constant of integration is zero.

Rearranging

$$R = \sqrt{\ln\left(\frac{x_2}{x_1}\right)\left(\frac{9\eta}{2(\rho - \rho_0)\,\theta^2 t}\right)} \qquad (4)$$

This is Svedburg's equation.

This relationship would give a measurement of particle size for a given angular velocity and time if a perfect spherical suspensoid was centrifuged in an infinitely small container. The complete assumptions of Stokes' law are given in Appendix A.

Since it is impossible to use an infinitely small container, and clay is not a perfect spherical suspensoid, corrections must be made for the following: (a) the broken platelike shape of clay particles (b) the hydrophilic nature of clay, (c) the acceleration and deceleration of the centrifuge, and (d) the point from which the particle is assumed to move, or the point of average centrifugal force, is not necessarily the physical midpoint of the liquid.

A review of these corrections will show that (a) and (b) cannot be determined directly, but will have to be found later from the results of microscopic analyses of the clay. Therefore, the equation should now be adjusted for all readily determinable experimental factors.

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The first one of these is the (c) or correction for time. By using a stop watch, the period required for the centrifuge to come from 0 r.p.m. to the desired speed was measured. The time for deceleration was also measured. By adding these two times and relating them to the total time of the test, not forgetting that the revolutions per minute over this time interval is one half of the desired revolutions per minute, and since the time varies as the square of the revolutions per minute, the factor 1.068 was obtained. In other words, t must be multiplied by this number.

It will be realized that because the bottom of the centrifuge tube is being filled with solid material during the test the point of average centrifugal force is displaced upward or toward the center. By experimentation it was found that a point two fifths of the distance from the top of the liquid to the bottom of the tube could be taken as the point of average centrifugal force.

Taking equation (4) and incorporating the two factors explained above an equation was obtained from which theoretical times and speeds for different particle sizes could be determined. Using these a sample of clay was separated into fractions of 10, 7 to 10, 3 to 7, 2 to 3, and under 2 mu. It was realized that these fractions would not be correct since there were still two corrections (a) and (b) to make to the original equation. We reasoned that by examining these fractions under the microscope we could obtain the missing factors.

The following technique was used to subdivide the sample into the above ranges:

One hundred milliliters of clay dispersion at 10% solids, having been deflocculated in a 0.1% solution of dispersing agent, was centrifuged in two 50-ml. centrifuge tubes. After the predetermined time interval the supernatant liquid was decanted into two other 50-ml. tubes and centrifuged for the next fraction. The sediment was saved. This system was repeated until the remainder was poured into a tared beaker and called the under 2-mu portion. The residue or sediment in the original two centrifuge tubes was redispersed in the solution of dispersing agent and made up to a total volume of 50 ml. in each tube, then recentrifuged. After the second centrifugation, the residues left when the suspensoid or supernatant liquid was decanted, were loosened and emptied into a tared beaker. The suspensoid was used to disperse the residue in the next pair of centrifuge tubes. The procedure was repeated until the remaining liquid was added to the beaker for the under 2-mu fraction.

This double procedure was used to insure better separation since when the particles are quite close together larger ones tend to pull smaller ones down with them. On the second pass the concentration is considerably reduced and so this effect is minimized. The average approximate distances of separation for the first and second passes are $^1/_2$ and 1 mu, respectively.

In brief, the system described above consisted of two passes using the most advantageous time and speed for each fraction obtained from equation (4). For the first pass, however, the time was increased by 50% over the calculated time. The calculated times were used for the second pass. This was done to insure the complete separation of the fraction desired. The fractions in the tared beakers were dried at 100°C. and weighed. The results were calculated as percentages. The actual size of the particles in each of these fractions was checked before drying by observing them under a microscope. The particle size was measured with a calibrated micrometer eyepiece at a magnification of 510× and checked at a magnification of 2130×.

It was found that while the over 2-mu portions were in fair agreement with microscopic analyses, the under 2-micron portion, at which incidentally Brownian movement begins noticeably, was very much in error. A comparison of the results obtained by the two methods, microscopic and centrifuge, showed that the variation could be resolved by means of a constant and a function of the diameter.

The next step was to determine this expression which would take the form $M(2R)^{1/K}$. From the foregoing results a correct time and speed were evolved for the 2 to 3-mu portion. This time and speed were now substituted into equation (4). In this way values were obtained for the function $M(2R)^{1/K}$, so that we could solve for M and K. The values for M appeared to be 0.355 for all clays, but varied for other substances, whereas K changed with the type of clay. For primary clay it was 4, for secondary clay 2, and other substances had their characteristic values. In this manner we were able to adjust equation (4) for (a) broken platelike shape and (b) hydrophilic nature of clay mentioned earlier. A correction for Brownian movement was also thought to be inherent in this expresssion although the complete theoretical significance was not investigated and would probably be considered a problem of its own.

Incorporating the foregoing function, equation (4) becomes

$$R = \sqrt{\frac{0.355(2R)^{1/K}[\ln(x_1 + y/x_1)]\ 9\eta}{2(\rho - \rho_0)\theta^2 t(1.068)}} \qquad (5)$$

where

$x_1 + y$ = the distance from the center to four fifths of the distance from the meniscus to the bottom of the tube (remembering that we originally assumed that the bottom one fifth of the tube had to be ignored to provide a safety factor)

This rather cumbersome equation may be greatly simplified for any given centrifuge to:

$$R^2 = M(2R)^{1/K}\left[\ln\left(\frac{20.53}{11.35}\right)\right]\frac{9(0.009)}{2(\rho - \rho_0)\theta^2 t(1.068)} \qquad (6)$$

Using D, diameter, in place of $2R$, grouping and substituting the value 0.355 for M, then multiplying by 10^8 to express as microns instead of centimeters we get:

$$D^{(2K-1)/K} = \frac{4(0.355)(0.592)9(0.009)}{2(\rho - \rho_0)\,\theta^2\ (1.068)} \times 10^8$$

$$= \frac{2(0.355)(0.592)9(0.009)}{(\rho - \rho_0)\,(1.068)\,t\,(\text{r.p.m.})^2\,(2\pi/60)^2} \times 10^8$$

$$= \frac{31{,}000 \times 10^4}{(\rho - \rho_0)\,(\text{r.p.m.})^2 t}$$

Since $K = 2$ for American (secondary) clay, and $\rho_0 = 1$ and $\rho = 2.56$, then for this clay

$$D = {}^2/_3\sqrt{\frac{19{,}900 + 10^4}{(\text{r.p.m.})^2 t}} \qquad (8)$$

Table I

Size, mu.	Time, sec.	Speed, r.p.m. Primary clay	Speed, r.p.m. Secondary clay
	First Pass		
Over 10	45	350	440
2–10	90	900[a]	900[a]
0.6–2	600	1100[a]	1050[a]
0.2–0.6	1600	1350[a]	1250
Under 0.2			
	Second Pass		
Over 10	30	350	440
2–10	60	900[a]	900[a]
0.6–2	400	1100[a]	1050[a]
0.2–0.6	1200	1350	1250
Under 0.2			

[a] Since this paper was presented these values have been changed to 1300.

A general equation for any substance could be

$$D = K/2K-1 \sqrt{\frac{87{,}500 \times 10^4 \times M}{(\text{r.p.m.})^2 t\,(\rho - \rho_0)}} \qquad (9)$$

Times and speeds were calculated from equation (8) and clay fractions were obtained using the procedure outlined. These fractions were examined microscopically and found to be in the chosen ranges. A sample of the same clay was checked in the laboratory of another supplier of clay using their long-arm centrifuge technique, and our results were found to agree very well with theirs. The variation which was always negative, i.e., less sedimented by the method developed than by the long-arm centrifuge method, was never greater than 5% of the total weight of clay analyzed. This variation increased from 2% at 10 mu to 5% at 1 mu and remained at 5% thereafter. Thus, since any error in particle size analysis, expressed in this way, is cumulative, the method we used and the long-arm centrifuge agree perfectly from 1.0 to 0.2 mu.

Let us consider the range above 1.0 mu. The particle size distribution which a domestic supplier claimed for this clay showed that the results obtained by the newly developed method were 5% in error on the positive side, i.e., the reverse of the results by the other laboratory. The differences encountered are probably due to differences in dispersion methods, which are particularly noticeable in the over 2-mu range. Both organizations claim that their methods are very accurate and since the results of the method we use lie in between, it is thought that this method is fairly accurate. Since a complete determination can be done in a matter of 2 hr. or less, we use it as a control method and will be referred to as such in this paper. It has the added advantage of being relatively simple.

Times and speeds which may be used for analysis of the two types of clay after the following conditions are observed are: (1) well deflocculated in 0.1% dispersing agent solution; (2) an original 10% clay dispersion; (3) a William Boekel Centrifuge, Type BA, with a 1/2-hp. motor; (4) the distance from the shaft to the top of the liquid, 11.35 cm.; (5) the distance from the shaft to the bottom of the tube, 22.15 cm.; (6) standard 50-cc. tubes (with metal shields for speeds over 900 r.p.m.); (7) metal shields alone for speeds of 1200 r.p.m. and over.

Table II

	Over 10	2–10	0.6–2	0.2–0.6	Under 0.2
First-grade secondary clay	2.5	10.0	35.0	35.0	17.5
First-grade primary clay	2.0	15.0	35.0	35.0	13.0
Second-grade primary clay	10.0	25.0	25.0	30.0	10.0

Table III

Type of pigment	Values for constants K	Values for constants M
Primary clay	4	0.355
Secondary clay	2	0.355
Ground calcite	0.85	0.450
Precipitated calcium carbonate	0.85	0.450
Satin white	2	0.355
Titanium dioxide A.W.D.	5	0.400

This procedure was also used to test other materials such as ground calcite, precipitated calcium carbonate, satin white, and titanium dioxide A.W.D. with equal success.

The times and speeds for these pigments were determined using equation (9).

A brief discussion of other methods is given in Appendix A. A good résumé of these methods of analyzing subsieve particles together with elutriation methods, turbidimetric methods, and permeability methods is given in a pamphlet by the American Society of Testing Materials called "Symposium on New Methods of Particle Size Determination in the Subsieve Range."

It was thought, however, that for the paper coater, the simplest, quickest, and best methods involved the use of a centrifuge. The theory of all centrifuge methods is a continuation of the theory of sedimentation and follows the pattern set by Romwalter and Vendl (*2*). The technique to be used is a matter of choice. All methods agree fairly closely. The only advantages claimed for the control method we use are simplicity and speed, together with reasonable accuracy.

Any centrifugal method of determining particle size gives the diameter, or in the case of clay, the average of the length and width, but not the thickness of the clay particle which is between 20 and 100 A. A particle for the purposes of centrifugal analyses is any crystal or group of crystals which acts as an entity in the clay slip. Thus, the method of dispersion greatly influences the results of centrifugal particle size analyses. It is, however, relatively easy to check the degree of dispersion by observing a drop of the over 10-mu fraction under a microscope. Agglomerates appear dark and can be seen to be composed of many particles, whereas single crystals appear transluscent. By ordinary clay dispersion methods, like those used in many coating mills, it was found that at least 50% of the over 10-mu portion consisted of agglomerates, while after dispersion in a homogenizer the per cent of agglomerates was only 15. The weight of the over 10-mu fraction also dropped by 35%.

The number of agglomerates over 10 mu in size tends to increase the smaller the average particle size of the clay when ordinary dispersion methods are used. The effect of the agglomerates, which are present at about 1% of the total, has not been completely investigated, but it is thought that they would (1) decrease the gloss and (2) tend to cause dusting. Since paper coating is not usually more than 8 to 10 mu thick when calendered, these agglomerates which tend to be more rounded than ordinary platelike clay particles, have a good chance of coming in contact with the steel rolls of the calender. The particles in an agglomerate are

Table IV. American Clay

	Particle size range					
	Over 10	*2–10*	*0.6–2*	*0.2–0.6*	*Under 0.2*	*All fractions*
Brightness, G.E.	80	79.5	81.5	81.5	81.0	80.0
Gloss, B & L, uncalendered	8	5	15	20	24	10
Gloss, B & L, calendered	29	27	41	52	56	48
Wet rub	5	6	4	2	1	3
Wax pick, uncalendered	4	4	4	4	4	4
Wax pick, calendered	3	4	5	5	5	4
K & N ink	5	1	3	4	6	2
Ink pick	25	25	26	24	23	26
Fold	2	1	4	5	3	..
Opacity	94	94	95.5	95	94	95
Adhesive demand	10.5	11	12.5	14.7	16.5	11

Note: The numbers in the tables for wet rub, K & N ink test, and fold indicate the order of the samples only, in all cases from best to worst as the numbers increase.

not wetted—otherwise it would be deflocculated to its component crystals or particles—therefore these particles are not sized. Thus, if the steel calender roll strikes these agglomerates it would tend to drive them into the paper, but it would also shatter them into a dust on the surface of the paper. A printing press would act in the same way. Much more work must be done to fully examine the effects of these agglomerates.

Samples of centrifuged fractions of a first-grade American coating clay and a first-grade English coating clay were saved and concentrated by sedimentation to produce 60% slips. The viscosity of these slips was tested using a Hercules Hi-Shear Viscometer. Portions of these slips were used in making coating color sized with casein and latex used in equal proportions such that the uncalendered wax pick was 4. Coated sheets were made with this coating color using a hand drawbar and a hand air brush coater. These sheets were calendered to obtain maximum gloss without calender blackening.

The results of tests on these sheets are given in Tables IV and V.

As may be seen from the tables, as the particle size decreased, the following qualities increased: (1) uncalendered gloss, (2) calendered gloss, (3) brightness, (4) adhesive demand, and (5) opacity.

Indications were that fold deteriorated and wet rub improved.

The brightness tended to increase as the particle size decreased down to 0.2 mu, but the fraction below this seemed to have slightly decreased brightness which is in line with the results reported by other observers.

Table V. English Clay

	Particle size range					
	Over 10	*2–10*	*0.6–2*	*0.2–0.6*	*Under 0.2*[a]	*All fractions*
Brightness, G.E.	79	82.5	85.5	86.5	85.0	80.0
Gloss, B & L, uncalendered	4	6	11	17	10	9
Gloss, B & L, calendered	22	35	51	61	56	50
Wet rub	2	5	4	1	6	3
Wax pick, uncalendered	..	4	4	4	4	4
Wax pick, calendered	..	5	3	4	4	3.5
K & N ink	6	4	1	2	5	3
Ink pick	..	31	30	29	24	30
Fold	1	5	4	2	6	3
Opacity	89	93	93	94	92	93
Adhesive demand	11.5	12.7	16.0	16.7	18.0	13.0

[a] Very viscous color, difficult to coat, air bubbles, and high viscosity caused lower gloss values than expected.

Note: The numbers in the tables for wet rub, K & N ink test, and fold indicate the order of the samples only, in all cases from best to worst as the numbers increase.

The opacity behaved in much the same way; after 0.2 mu it fell off noticeably. While it was well known that gloss would increase as particle size decreased, the extent of the increase was much greater than anticipated. The same thing might also be said for the adhesive demand. The results of tests of coating strength, or pick test, seemed rather mysterious. While the Dennison wax test was a constant 4 wax for uncalendered sheets, it increased on the calendered sheets as the particle size decreased. On the other hand, the ink pick test run on a machine similar to that by Davidson (*10*) showed some indication of a slight decrease as the particle size decreased. We will discuss this phenomenon later. The tests for wet rub, coating adhesion on a fold, and K & N testing ink smears were inconclusive. See Appendix B for description of the wet rub tester.

Viscosity tests on the 60% clay slips using the Hercules Hi-Shear Viscometer gave vivid evidence of the increase in viscosity and particularly dilatancy with decreasing particle size. One particularly peculiar effect observed was that the finer regulated particle size fractions had a work-hardening characteristic curve, i.e., the opposite of thixotropy. This effect was present regardless of the bob used. The reason for this is at present unknown, but it is suspected that it results from the inability of clay of a specific particle size to pack. It is thought that the general increase in viscosity with lowering particle size is due to the fact that since there are more particles present there is much more surface and therefore more liquid is required to wet the surface and less to act as a lubricating layer. Interesting results might have been obtained by a variation of the solids of the clay slips for the same viscosity, but this was not done due to the limited amount of material. This takes us back to the reason for our investigation. We have shown that the different fractions under 2 mu have different characteristics although by the usual method of reporting particle size they would all be considered the same, whereas under 2 mu they are actually quite different.

This paper is concluded with a discussion of the effects observed with change in particle size. Some of the observations are not much more than general deductions, but they are included to provoke discussion.

It was noted that a large amount of foreign matter was carried down with the first two fractions, thereby reducing the brightness. This dirt was quite readily discernible by eye. We did not analyze the dirt, but were quite careful in selecting our clay samples and feel fairly confident they were representative of the full boxcar. The drop-off of brightness in the under 0.2-mu portion was due to the fact that opacity had also decreased for this portion and consequently the raw stock showed through more than with the two previous fractions. It has been stated by manufacturers of ultrafine pigments that low particle size material has less hiding power.

Possible reasons for the increase in gloss with decreasing particle size are: (1) there are more separate reflecting surfaces in the top layer of coating, and (2) there is more total reflecting surface in the top layer of coating.

Since all the sheets were made to give an uncalendered wax pick of 4, calendering decreased the strength

of large particle size coatings and increased the strength of small particle size coatings, as shown by the calendered wax pick tests. The ink pick tests compared with the calendered wax pick tests showed that for a given wax pick the ink pick was higher for large particle size coatings and smaller for small particle size coatings. The reason for this might be the fact that a wax pick would adhere better to large surfaces of large particles rather than many small surfaces of the small particles. The ink used in the ink pick tests would adhere just as readily to large or small size particles. The problem of pick testing is being investigated as a separate project and we hope that we will be able to give more practical and theoretical aspects at a later date. This problem has already been discussed at previous meetings, notably by Davidson (*10*).

The adhesive demand of the small particle fractions was greater because there were more particles to be adhered to the paper and thus more surface to be covered with adhesive.

The best looking sheets of coated paper were obtained from the clay fractions of from 2 to 0.2 mu. The best individual fraction is around 0.5 mu, but from viscosity considerations better coating results would be expected from a range of particle sizes.

Referring to Table III, it was observed that the particle size of satin white lay in the preferred range for clay mentioned above; also K and M for satin white were the same as for domestic clay. Satin white appeared to have long cylindrical particles when observed under the microscope. While more viscous than clay, it has the same characteristic dilatant curve as clay though most other pigments tend to have a pseudoplastic viscosity curve. Satin white acts in coating more like clay than any other pigment we investigated, i.e., it is glossy and has more hiding power than would be expected.

APPENDIX A

1. Microscopic analysis of a very dilute pigment dispersion mounted on a slide is very efficient, but long and laborious. It is, however, a very effective method of checking. Using an ordinary microscope, particles may be measured down to 0.5 mu. From 0.5 to 0.3 mu the particles appear to be white dots. At 0.2 mu the particles are black spots which gradually become grayer and grayer as the size diminishes, finally disappearing from view at 0.1 mu. Thus, particles of size from 0.5 to 0.1 mu may be counted or distinguished even though they may not be physically measured using an ordinary microscope.

2. Sedimentation methods for particle size analyses follow the same principles as centrifugal methods, i.e., Stokes' law assuming: (1) sphericity, smoothness, and rigidity of particles, (2) discontinuities of the medium are small, and (3) time for the particle to assume its terminal velocity is negligible. The cumulative sedimentation method measures directly the weight of particles sedimented in a pan (*6*) suspended at the bottom of a sedimentation column as a function of the time.

The following equation applies:

$$p = s + tdp/dt$$

where

p = total weight of sedimented material falling on the pan
t = the time of sedimentation
s = that portion of the total particles p which have fallen a distance h in time t, i.e., that fraction which it was desired to sediment in time t
tdp/dt = the finer particles than portion s which also settled although their settling times are greater than t

From the evaluation of the two fractions from p the total weight sedimented is obtained using Oden's method of tangential intercepts (*6*). The time in minutes is plotted against p.

The percentage of the total sedimented s is obtained for any given p by the intercept of the tangent to the curve at p with the y axis.

Other cumulative methods measure the change in concentration by change in static head pressure rather than by weighing the amount of pigment sedimented (7)

Increment sedimentation methods analyze the concentration of the sedimenting column at some specific level. Using a pipet method (*8*), a specific volume of suspension is taken from the level mentioned at definite time intervals, the liquid is dried and weighed and the concentration determined. The hydrometer method (*9*) is simpler than the pipet method, in that it determines the density and thus the concentration at a glance. By determining the change of concentration with time the amount sedimented and thus the particle size may be determined. Both of these sedimentation methods, while accurate, are only effective above 2 mu.

3. Centrifugal methods are often used in conjunction with the above sedimentation methods. A common technique is the beaker-type centrifugation (*3*) which is very similar to the control technique suggested above. Usually only a single pass is made instead of the two passes mentioned above. This pass is made at specific revolutions per minute and may be discontinuous as above, i.e., the sedimented material weighed at definite time intervals, or continous, measuring the change in concentration with a hydrometer. Using the single pass at one definite speed, Oden's method of tangential intercepts may be used in the same manner as mentioned above under cumulative sedimentation methods.

The long-arm centrifuge (*4*), having arms about 30 cm. in length, is a favorite method of particle size determination of clay by ceramic laboratories and clay manufacturers. This method is usually continuous, testing the concentration of the supernatant liquid with a hydrometer. Low revolutions per minute and long time intervals are also customary.

APPENDIX B

The wet rub test was carried out on a piece of apparatus we call the Gunning Wet Rub Tester which we use for routine work. It was built to take the variables out of the wet finger rub test. It consists of a weighted metal frame 13 in. long. The half nearest the operator is a slide in which a small bearing assembly travels. From this slide an arm extends forward terminating in a head into which is inserted a rubber stopper ground to a rounded chisel-like point about $^3/_8$ in. wide. This rubber point extends downward through a slot so that it rests on the paper with a constant pressure provided by the weight of the stopper and holder. The arm connection at the bearing assembly allows unrestricted movement in a vertical

arc. Lines are scribed at the side of the slot, one at the center, and two others $1^1/_2$ in. on either side. A third line is found 2 in. from the center toward the slide.

To conduct a test the sample is placed so that it laps a piece of black paper by $^1/_2$ in. The frame is then placed over these papers to bring the line nearest the slide above the edge of the sample. A single drop of water from an eyedropper is let fall on the paper at the center line, the rubber finger is gently lowered on to the drop and allowed to rest there under its own weight. The slide at the rear of the instrument is then moved backward and forward for the required number of strokes between stops so that the finger moves up and down on the paper from one scribed limit to the other. After the required number of strokes, depending on the grade of paper, a catch is released on the slide so that it may be drawn right back which pulls the finger off the sheet and on to the sheet of black paper. This distances are arranged so that the finger travels across $^1/_2$ in. of paper which has not been rubbed and about 1 in. on the black paper. The smear thus put on the black paper is allowed to dry and compared to the standard. A numerical value can be obtained by substituting a small glass plate for the black paper and then weighing the quantity of material.

LITERATURE CITED

1. Knapp, R. T., "New Apparatus for Determination of Size Distribution of Particles in Fine Powders," *Ind. Eng. Chem. Anal. Ed.* 6: 66 (1934).
2. Romwalter, A., and Vendl, M., *Kolloid-Z.* 72: 1–3 (1935).
3. Martin, S. W., *Ind. Eng. Chem., Anal. Ed.*, 11: 471 (1939).
4. Norton, F. H., and Speil, S., *J. Am. Ceramic Soc.* 21: 89 (1938).
5. Svedburg, T., "Colloid Chemistry," pages 148, 149, New York, N. Y., Chemical Catalog Co., 1928.
6. Oden, S., *in* Alexander's "Colloid Chemistry," vol. 1, page 861, New York, N. Y., Chemical Catalog Co., 1926.
7. Kelly, W. J., *Ind. Eng. Chem.* 16: 928 (1924).
8. Loomis, G. A., *J. Am. Ceramic Soc.* 21: 393 (1938).
9. Bouyoucos, G. J., *J. Am. Ceramic Soc.* 20: 257 (1937).
10. Davidson, G., *Paper Mill News* pages 16–18 (May 7, 1949).

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Effect of Chip Size in Alkaline Pulping

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Slash pine chips, much smaller in cross section than standard mill-size chips, have been pulped. Land yield data, chemical analysis, and physical strength of resultant pulps are compared to those obtained by pulping regular chips under identical conditions. Chip reduction was obtained mechanically by use of a hammer mill with $^1/_2$-in. expanded metal discharge screen. In one case, dry chips were fed to the hammer mill. In the second instance, chips were steamed 10 min. at 170 p.s.i. in dilute sodium carbonate solution before being fed to the mill. Mechanically treated chips were separated into screen fractions of 4, 6, 8, 10, and 16-mesh. These screen fractions indicate cross-section dimensions at right angles to the grain as all fractions were about as long in grain direction as untreated chips. These small cross-section chips can be pulped to about 50% screened yield in 1.5 hr. as compared to 43.4% in 2.5 hr. from regular chips cooked under identical conditions. Pulps from chips hammer-milled without steaming are slightly lower in tear but otherwise as strong as pulps from regular chips. Pulps from chips which had been hammer-milled after presteaming were stronger in tear and fold and about equal in other factors when compared to pulps made from regular chips. Physical strength values of pulps made from small size chips remain about constant from 4 through 8 mesh, 10-mesh shows a slight decrease and 16-mesh shows a definite drop in strength. Hammer-milling of dry chips prior to cooking offers good promise to present mill operation. Bulk density is 24% higher than regular chips, yields of screened pulp are 50 instead of 43.4%, and cooking time is reduced by 1.0 hr. from the 2.5 hr. for regular chips. Shorter cooking times with tolerance of some screenings in pulp offer prospects of even higher yields if hot refining is used. The application of hammer-milling chips which have been presteamed should be confined to continuous pulping. Bulk density of treated wood is only 77% that of regular chips. Chip ends are broomed out and chips appear somewhat porous, making them well suited for high reaction velocity with minimum degradation.

Recent developments in alkaline pulping research (*1*) have indicated that the extent of surface area of wood chips exposed to the cooking chemicals plays a vital role in the speed of reaction and in the characteristics of the pulp produced from the reaction. If surface area of wood chips is to be expanded in order to utilize the advantages of increased contact area between wood and chemical, it is obviously necessary to perform mechanical work on the chips, subdividing them into smaller units.

Very little is known as to the effects of this mechanical subdivision on the chemical and physical qualities of the resultant pulps. Processes, such as the Asplund, have been devised whereby the chips are subdivided after mild chemical treatment but the usages to which the resultant pulps were put did not demand critical evaluation of the effects produced by the mechanical treatment. For example, a good quality wallboard may be produced if a large percentage of wood fibers is cut by the mechanical action while another large percentage is left in the form of fiber bundles.

The main purpose of this investigation is to determine whether mechanical treatment of the wood chips prior to pulping causes any appreciable damage to the cellulose fibers and what effect this mechanical treatment has on the pulping reaction. There is very little background material to be found in the literature of alkaline pulping and what little there is treats mainly on the variations in pulping caused by differences in chip size as produced by commercial chippers.

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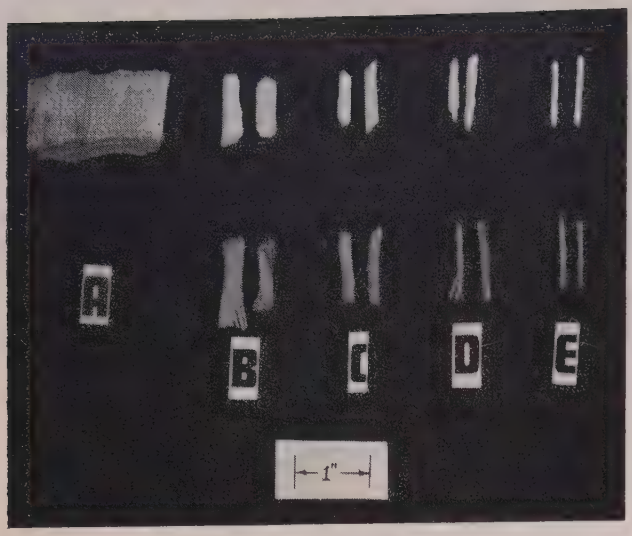

Fig. 1. Comparative sizes of pine chips for pulping

Cable, McKee, and Simmons (*2*) in 1926 published the results of work done on the soda pulping of aspen, white birch, and other hardwoods. They studied chips which varied in length in the grain direction between 0.5 and 1.25 in. They were unable to determine any significant differences in yield, bleach requirements, or loss in bleaching attributable to length of chip. However, no data were given concerning the effect of chip length on physical strength of the resultant pulps.

Chesley and Robertson (*3*) investigated the effect of chipper fines of $^1/_4$ and $^1/_8$-in screen mesh. They found that the fines, when cooked alone, gave 93% as much pulp as regular chips. When fines were mixed with regular chips, yields were realized which agreed with yields calculated from the relative proportions of fines and full-sized chips. It was found that $^1/_8$-in. chips when cooked alone produced pulps with tear and burst values lower than pulps produced from standard chips.

Suttle (*4*) cooked southern pine chips varying in length from $^1/_4$ to $1^1/_2$ in. by the sulphate process. He found that, at constant cooking time, the small chips produced pulps with a permanganate number of 14, as compared to 21 for the large chips. Total yields were higher for the large chips (45%) than the 41% realized from the $^1/_4$-in. chips. No appreciable change in strength was observed.

Robertson (*5*) cooked chips of different sizes, $^1/_8$ to $^1/_2$ in., $^1/_8$ to $^3/_4$ in., $^3/_4$ to 1 in., and over 1 in. He found that the smallest size chips resulted in screened yields of 52.5% as compared to 46% for the largest chips. Strength values of the resultant pulps were not harmed until chips were reduced in size to between $^1/_8$ and $^1/_2$ in.

In planning this work it was recognized that the fewer the cuts made across the grain of the chip the less damage would be done to the length of the fibers. Chesley and Robertson (*3*) showed this to be true. The apparently conflicting data of Suttle (*4*) and Robertson (*5*) showed that, even though the smaller chips produced lower total yields than the larger chips, the increased surface of the smaller chips permitted more thorough pulping and consequent higher screened yields. This is further borne out by Suttle's lower permanganate numbers for the smaller chips. Both total and screened yields must be watched in order to get the true picture.

It was decided, therefore, to carry out the mechanical treatment in such a way that the length of chip in the grain direction would be preserved as much as possible. Size variations would be obtained by changing the cross-sectional areas of the various fractions. Obviously this called for a mechanical treatment which involved the maximum of splitting along the grain with a minimum of cutting across the grain. The size fractions of chips to be studied would be obtained by screening in such a way that cross section of chip controls the size fraction. Thus, screen fractions were obtained where cross sections were held on 4 mesh, passed 4 mesh and were retained on 6 mesh, passed 6 mesh and were retained on 8 mesh, etc.

Each of the screen fractions should then be subjected to identical cooking conditions. Standard mill-type cooking conditions should be used so that results can be compared to those obtained from standard size chips cooked by regular mill methods. It should be possible, after these studies, to state definitely whether mechanical treatment will cause irreparable damage to the cellulose fibers, whether such treatment results in any advantages to the pulping process, and whether these advantages might warrant the expense of such mechanical treatment.

There is not intention in this paper to recommend any definite commercial application for mechanical processing of chips prior to pulping. This is, rather, an academic investigation into what physical and chemical effects are produced by such mechanical pretreatment. A great deal of further work on both a laboratory and pilot-plant scale would be required before any definite recommendations could be made. It is hoped this work will show that the possible advantages to be gained by mechanically increasing the chip surface will warrant further studies toward producing such changes economically.

PROCEDURE

A large quantity of slash pine chips was obtained from the Hudson Pulp and Paper Co. at Palatka, Fla. These chips were taken from the conveyor belt after the chipper screens, and were $^3/_4$ to $^7/_8$ in. in length. Chips were kiln-dried to 8 to 9% moisture and stored in well-ventilated bins.

One batch of chips was fed to a 5-hp. Sturtevant swing-hammer mill. The discharge screen in the mill was made from $^1/_2$-in. expanded metal with a diamond-

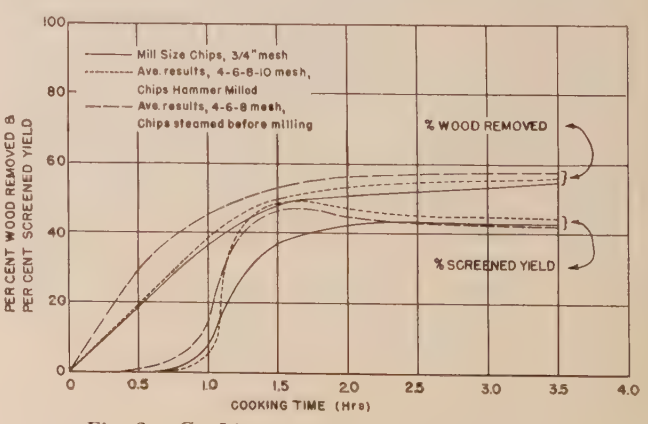

Fig. 2. Cooking curves—varying chip size

shaped opening, $^7/_8$ in. along the long axis, $^3/_8$ in. along the short axis. The split chips from the hammer mill were then screened on a gyratory screen. Screens of 4, 6, 8, 10, and 16 mesh were used successively to separate the various screen fractions. It was found that this method of screening permitted the chip fragments to pass through the screens in an endwise direction resulting in a size classification according to cross-sectional area. The per cent of total wood made up by each fraction was determined and each fraction was stored in its airtight container pending pulping experiments.

The appearance of the various screen fractions produced as described above indicated that some erosive action might be taking place in the hammer mill. Individual wood pieces showed a surface which appeared to be somewhat polished and their ends were rounded. For that reason, another batch of chips was prepared in which the chips were softened prior to hammer-milling.

Softening was achieved by steaming the chips in dilute Na_2CO_3 solution for 10 min. at 170 p.s.i. Only sufficient carbonate (1.7% based on wood) was added to keep the solution alkaline, preventing acid hydrolysis as much as possible. The pH at the end of the steaming period was 8.3. Per cent of original wood realized after steaming was determined. The wet softened chips were then passed through the hammer mill exactly as dry untreated chips had been previously processed. The hammer-milled product, in this case, showed considerable brooming out at the ends of the wood pieces with no sign of surface erosion. The chips had been darkened considerably by the steaming process.

The steamed and hammer-milled material was oven-dried, then separated as before into sized fractions by successive screening through screens of 4, 6, 8, 10, and 16 mesh on the gyratory screen. Each fraction was stored for future pulping tests.

Dry hammer-milled chips and steamed hammer-milled chips of each screen fraction were pulped in equipment previously described (*6*). Cooking conditions for each fraction were as follows: total cooking time 1.0, 1.5, 2.0, 2.5, 3.0, and 3.5 hr., time to maximum cooking pressure, 1.0 hr.; maximum cooking pressure, 115 p.s.i.; per cent chemical, 16, expressed as Na_2O, based on dry wood charged to the digester; chemical concentration, 50 g.p.l.; sulphidity 25%; liquor–wood ratio 3.36:1. A similar series of cooks was carried out on untreated chips as received from the mill, using the same cooking conditions as described above.

All pulps were washed and screened through a 10-cut screen. Screened yield and per cent screenings were determined, from which total yield was calculated. Yield values for the chips steamed before hammer-milling were determined on a basis of dry material charged to the digester. These values were later corrected back to an unsteamed wood basis by taking into account the woody material lost in the steaming process. All pulps cooked for a total of 1.5 and 2.0 hr. were tested for tear, burst, tensile and double folds, strength values being expressed according to TAPPI Standard T 220 m. Those times of 1.5 and 2.0 hr. were used because previous tests had shown that mill-sized chips produced strongest pulps at these times under the cooking conditions used. Lignin, pentosan, and permanganate values were determined for selected pulps by TAPPI standard methods. In permanganate numbers, 75 ml. of permanganate solution were used.

Table I. Screen Analysis of Hammer-Milled Pine Chips

$^1/_2$-In. Expanded Metal Screen in Mill Discharge

Screen mesh size	*Chips milled dry, %*	*Chips steamed before milling, %*
+4	41.6	43.4
−4+6	28.8	29.0
−6+8	11.4	11.5
−8+10	6.2	5.6
−10+16	6.0	6.1
−16	6.0	4.4
	100.0	100.0
Screen Analysis of 4-Mesh Fraction		
+2	2.3	0.6
−2+3	18.1	17.5
−3+4	66.7	67.4
−4	12.9	14.4
	100.0	99.9

PRESENTATION OF DATA

A tabulation of the screen analysis for both steamed and untreated chips after hammer-milling is presented in Table I. The analysis of the no. 4 mesh fraction is included in order that it may be seen how far even this coarsest fraction deviated in size from the original chips. Figure 1 shows the relative appearance of each screen fraction as compared to an average mill chip. The original chip is shown at A; +4 mesh fraction at B; −4 +6 mesh at C; −6 +8 at D, and −8 +10 at E. The upper row represents dry hammer-milled material while the lower, darker colored row resulted from milling chips which had been previously softened by steaming. The eroded appearance of the untreated material and the broomed appearance after steaming are quite apparent. It is also quite clear from the figure that the grain direction of the chip was not altered appreciably by the milling process.

In Table II are compiled all of the cooking data and pulp analyses for each material cooked. It is to be noted that the yield values for material steamed before milling have been corrected back to original unsteamed wood. It had been found that steaming 10 min. at 170 p.s.i. caused a loss of 6.0% of original wood. The yield values, based on wood charged to the digester, were multiplied by the factor 0.94, resulting in a yield value which represented residue after both steaming and cooking losses had been deducted.

The actual yield values, based on wood charged to the digester, obtained from cooking wood which had been previously steamed are shown in Table III.

Figure 2 is a graphical presentation of the cooking data. It should be noted that average values for a wide range of screen sizes of hammer-milled material are used. Attempts were made to plot the data for each screen size but the curves were so close as to make any distinguishing between screen size unintelligible.

A mathematical vindication of this decision to average the results over a wide range of screen sizes is presented in Tables IV and V. Table IV presents the deviations from the average values of total and screened yield for each screen size obtained by hammer-

milling untreated wood. Table V is a similar compilation for wood steamed prior to milling.

Strength development data for all pulps tested are presented in Table VI. In all cases pulps cooked for a total of 1.5 and 2.0 hr. were tested. A study of these strength values showed that no appreciable drop in strength occurred until chips became smaller in cross sections than 8 mesh. For that reason, strength values for +4, −4 +6, and −6 +8-mesh chips were averaged. These average values, with maximum deviation from the mean, are presented in Table VII. The deviation is not designated by plus or minus sign, as the larger deviation, whether plus or minus, was tabulated in each case.

Figure 3 is a graphical comparison of these average strength values for pulps cooked 1.5 hr. in the size range between 4 and 8 mesh with corresponding strength values of pulps produced from untreated chips. Figure 4 is a similar plot for pulps cooked for a total of 2.0 hr.

DISCUSSION

Mechanical Treatment of Chips

There is always the danger, in any mechanical work

Table II. Cooking Data and Chemical Analysis for All Pulps

Type chip cooked	*Chip size, screen mesh*	*Cook time, hr.*	*Yield*[a] *Total % of orig. wood*	*Yield*[a] *Screened % of orig. wood*	*Screenings, % of pulp*	*Analysis of pulp* *Lignin %*	*Analysis of pulp* *Pentosan, %*	*Analysis of pulp* *Permanganate no.*
Mill size	3/4	1.0	63.7	6.4	90.0	...	...	...
		1.5	52.2	38.0	27.2	9.2	7.6	46.4
		2.0	49.2	41.3	16.0	7.7	7.8	34.7
		2.5	48.0	43.4	9.5	...	...	...
		3.0	46.1	42.7	7.4	5.4	7.7	33.9
		3.5	45.0	42.7	5.2	...	...	...
Mill chips, hammer-milled, screened	4	1.0	63.3	4.7	93.2	...	...	...
		1.5	50.2	43.0	14.5	10.7	7.4	35.3
		2.0	46.9	46.3	1.3	5.6	7.5	27.7
		2.5	43.7	43.7	0.0	...	...	...
		3.0	43.9	43.9	0.0	...	...	...
		3.5	43.8	43.8	0.0	...	...	...
Mill chips, hammer-milled, screened	6	1.0	61.7	4.6	92.6	...	...	...
		1.5	50.5	50.2	0.5	12.5	7.4	45.3
		2.0	46.6	46.6	0.0	6.5	7.2	34.0
		2.5	46.0	46.0	0.0	...	...	...
		3.0	45.0	45.0	0.0	...	...	...
		3.5	45.3	45.3	0.0	...	...	...
Mill chips, hammer-milled, screened	8	1.0	61.7	5.3	91.5	...	...	...
		1.5	51.4	51.3	0.1	8.5	7.4	45.3
		2.0	48.0	48.0	0.0	5.9	7.9	34.0
		2.5	45.9	45.9	0.0	...	...	...
		3.0	45.0	45.0	0.0	...	...	...
		3.5	44.5	44.5	0.0	...	...	...
Mill chips, hammer-milled, screened	10	1.0	61.0	6.1	90.1	...	...	...
		1.5	49.3	49.2	0.2	8.3	8.0	39.2
		2.0	46.9	46.9	0.0	...	...	31.2
		2.5	45.1	45.1	0.0	...	...	...
		3.0	44.2	44.2	0.0	...	...	...
		3.5	44.0	44.0	0.0	...	...	...
Mill chips, steamed 10 min. at 170 p.s.i., hammer-milled, dried, and screened	4	1.0	55.2	12.0	78.3	...	...	...
		1.5	47.2	47.1	1.1	7.9	5.4	31.7
		2.0	44.5	44.3	0.3	7.9	5.4	25.4
		2.5	43.4	43.3	0.1	...	...	...
		3.0	43.2	43.2	0.1	...	...	...
		3.5	42.0	42.0	0.0	...	...	...
Mill chips, steamed 10 min. at 170 p.s.i., hammer-milled, dried, and screened	6	1.0	54.3	15.3	72.1	...	...	...
		1.5	47.2	46.7	1.0	8.0	5.2	36.7
		2.0	44.3	44.3	0.0	4.7	5.6	24.6
		2.5	43.0	43.0	0.0	...	...	...
		3.0	42.4	42.4	0.0	...	...	...
		3.5	42.2	42.2	0.0	...	...	...
Mill chips, steamed 10 min. at 170 p.s.i., hammer-milled, dried, and screened	8	1.0	54.2	13.6	75.0	...	...	...
		1.5	45.9	45.7	0.3	7.3	5.6	31.3
		2.0	44.2	44.2	0.0	5.2	5.6	26.5
		2.5	42.5	42.5	0.0	...	...	...
		3.0	42.0	42.0	0.0	...	...	...
		3.5	42.0	42.0	0.0	...	...	...
Mill chips, steamed 10 min. at 170 p.s.i., hammer-milled, dried, and screened	10	1.0	53.3	18.2	66.0	...	...	...
		1.5	45.3	44.7	1.4	8.5	5.7	36.0
		2.0	43.0	43.0	0.0	5.3	6.2	27.0
		2.5	43.0	43.0	0.0	...	...	...
		3.0	42.1	42.1	0.0	...	...	...
		3.5	...	...	...	...	...	...
Mill chips, steamed 10 min. at 170 p.s.i., hammer-milled, dried, and screened	16	1.0	53.7	13.2	75.5	...	...	...
		1.5	...	...	...	...	...	...
		2.0	42.1	42.1	0.0	5.5	6.3	25.1
		2.5	41.2	41.2	0.0	...	...	...
		3.0	40.1	40.1	0.0	...	...	...
		3.5	...	...	...	...	...	...

All pulps cooked at 115 p.s.i. steam pressure, 1.0 hr. to maximum pressure; cooking liquor 50 g.p.l. expressed as Na_2O, 25% sulphidity, 16% chemical (Na_2O) based on dry wood.

[a] Yield values for pulps made from chips steamed before hammer-milling were corrected to per cent of original wood before steaming. (6.0% of wood dissolved by steaming.)

Table III. Pulp Yields from Chips Steamed and Hammer-Milled

Based on Wood Actually Charged to Digester

Cooking time, hr.	Size of material in screen meshes per inch: +4	−4 +6	−6 +8	−8 +10	−10 +16	Average of 4, 6, and 8 mesh
Total Yield (Per Cent of Wood Charged to Digester)						
1.0	58.8	58.2	57.6	56.7	57.0	58.2
1.5	50.2	50.1	48.8	48.2	...	49.7
2.0	47.3	47.1	46.9	45.7	44.8	47.1
2.5	46.1	45.8	45.2	45.8	43.8	45.7
3.0	46.0	45.1	44.6	44.9	42.7	45.2
3.5	44.7	44.8	44.6	...	...	44.7
Screened Yield (Per Cent of Wood Charged to Digester)						
1.0	12.8	16.2	18.0	19.3	14.0	15.7
1.5	49.6	49.6	48.7	47.5	...	49.3
2.0	47.2	47.1	46.9	45.7	44.8	47.1
2.5	46.1	45.8	45.2	45.8	43.8	45.7
3.0	46.0	45.1	44.7	44.9	42.7	45.3
3.5	44.7	44.8	44.6	...	...	44.7

on chips prior to pulping, that average fiber length will be decreased during the operation. In that case any advantages of speed or uniformity of pulping may be overbalanced by loss in strength of the resultant pulps. Therefore, the most logical method of size reduction seems to consist of a treatment which splits the chips along the grain with a minimum of fracture across the grain direction.

The size and shape of the discharge screen in the hammer mill have been found to be of prime importance in the accomplishment of this aim. The usual punched plate screens are entirely unsatisfactory as they tend to hold the chips in the mill until a high percentage of the material has been reduced to flour. Expanded metal screens work quite well permitting very short retention time of the chips in the mill. The larger the cross section of the expanded metal, the shorter the retention time but also the less work done on the chips. The ideal discharge screen would appear to be one made from slotted plates with the slots at right angles to the axis of rotation of the mill.

Table I gives the size reductions obtained after dry chips and chips softened by presteaming have been subjected to a single pass through a hammer mill with $^1/_2$-in. expanded metal as the discharge screen. It is to be borne in mind that the screen mesh sizes are an indication of the cross-sectional size classification, not an average dimension classification. In all cases chips

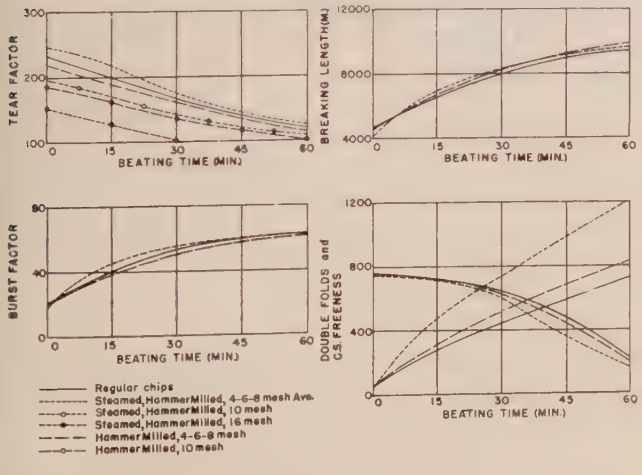

Fig. 3. Variations in pulp strength with chip size (all pulps cooked 1.5 hr.)

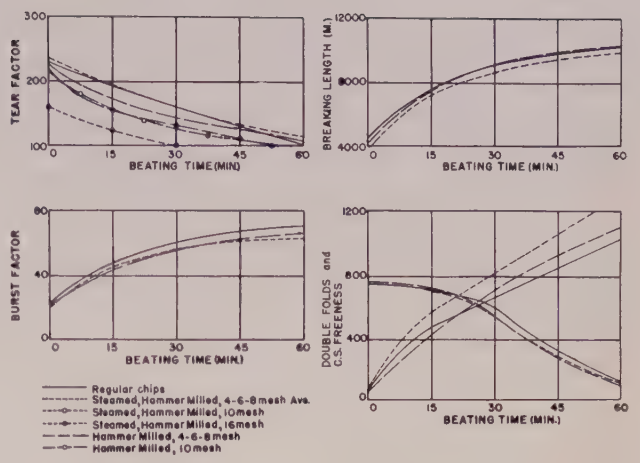

Fig. 4. Variations in pulp strength with chip size (all pulps cooked 2 hr.)

passed through the various screens in an edgewise direction made possible by the gyratory action of the screening mechanism.

Subsequent discussion will show that no measurable damage from physical strength consideration has been done to material of 8 mesh or larger. Therefore, 82 to 84% of all material processed through the $^1/_2$-in. screen has lost none of its papermaking potential. An additional 12% has been only partially damaged while 5 to 6% retains very little of its papermaking potential.

Expanded metal screens of $^3/_4$ in. were used but over 85% of the material thus treated was retained on 4 mesh indicating that not sufficient work had been done on the chips to warrant the mechanical treatment.

The screen analyses listed in Table I do not show the true differences in material realized from milling unsoftened and softened chips. These differences can best be seen by a study of Fig. 1. The upper row of chip fragments resulted from milling dry chips while the lower row represents chips which had been softened before steaming. The dry chips present an eroded appearance indicating that the action of the hammers and passage through the screen may have worn away the sharp edges of the dry, nonresilient chips. Length of chip fragments was, in general, the same as the length, in the grain direction, of the original chips. The chips which had been softened prior

Table IV. Deviation of Yield Values from the Average

Dry Chips Hammer-Milled

Cooking time, hr.	Average yield for 4, 6, 8, and 10-mesh chips, % of orig. wood	Deviation from average, %: 4 mesh	6 mesh	8 mesh	10 mesh
Total yield (Per Cent of Original Wood)					
1.0	61.9	+2.3	−0.3	−0.3	−1.5
1.5	50.4	−0.4	+0.2	+0.2	−2.2
2.0	47.1	−0.4	−1.1	−1.1	−0.2
2.5	45.2	−3.3	+1.8	+1.8	−0.2
3.0	44.5	−1.4	+1.1	+1.1	−0.7
3.5	44.4	−1.3	+2.0	+0.2	−0.9
Screened yield (Per Cent of Original Wood)					
1.0	4.7	0.0	−2.1	−25.5	+29.8
1.5	48.4	−11.2	+3.7	+6.0	+1.6
2.0	47.0	−1.5	−0.8	+2.1	−0.2
2.5	45.2	−3.3	+1.8	+1.5	−0.2
3.0	44.5	−1.4	+1.1	+1.1	−0.7
3.5	44.4	−1.3	+2.0	+0.2	−0.9

to milling showed none of this eroded appearance. The softening appeared to impart sufficient flexibility and resilience to the chip so that the ends are definitely broomed out rather than eroded. In addition, the presteaming appeared to give the chips a somewhat porous appearance.

The dark appearance of the steamed chips indicates that some price had to be paid chemically to attain the advantage of physical softness. It was found that 6.0% of the wood was lost by chemical action in the steaming process. Slightly over half of this loss was in the form of pentosan. The original dry wood contained 9.1% pentosan. The steamed wood contained, on a dry basis, 6.3% pentosan. This 6.3% converted back to original wood basis, became 6.3 × 0.94% or 5.9%. Therefore, 9.1 − 5.9 or 3.2% pentosan was lost. This loss occurred in spite of the fact that the steaming solution was kept alkaline throughout the 10-min. steaming process. Pentosan was probably lost due to acid hydrolysis inside the chip before the carbonate solution penetrated to that portion of the chip. Chemical losses would, of course, have been much higher if alkalinity had not been maintained during steaming.

Some of the advantages of the steaming process were unquestionably lost because the milling operation could not be carried out immediately after blowing the steamed chips. The hammer mill employed was located about 1/2 mile from the laboratory, entailing an unavoidable delay. Maximum advantage of softening would be realized if milling could be carried out in a pressure-tight mill so that the steam pressure could be reduced as the material passed the discharged screen.

Effect of Chip Size on Rate of Pulping

Tables II and III contain yield and screenings data for pulping all the chip sizes studied. Table III contains the yield data for chips which had been steamed prior to pulping and per cent yield figures in this table have been calculated on a basis of actual material charged to the digesters. Before these results could be compared directly to similar results for previously untreated wood they had to be converted to a basis of original untreated wood, taking into account the 6.0% wood already lost before pulping. These corrected values of yield are used in Table II.

The data indicate that rate of pulping is increased as chip size is decreased, as would be expected. Contrary to expectations, this increase in rate is not progressive as chip size diminishes. Comparison of total yield values for mill size chips versus 4-mesh chips shows that full size chips give higher yields than do the smaller chips. However, there is no appreciable change in total yield as chip sizes get progressively smaller from 4 mesh down to the very fine 10 mesh size.

A study of screened yield values shows that very appreciable advantages are to be gained by reduction in chip size. Maximum screened yield obtainable from chips is 43.4%, attained at a cooking time of 2.5 hr. Mechanical treatment prior to pulping makes possible the realization of screened yields of 49.2 to 51.3% in 1.5 hr. total cooking time. (Screened yield and per cent screenings values for 4-mesh unsteamed chips cooked 1.5 hr. are undoubtedly in error. This could readily be explained by accidental plugging of part of the wood in one end of the digester at the start of the cook.) If all pulps are allowed to remain in the digester for 3.5 hr., most of this advantage of increased screened yield is lost.

The obvious explanation for this marked difference in maximum screened yield is one of more uniform pulping as chip size diminishes. In the case of large chips, a considerable amount of potential screened yield is held in the form of screenings for extended periods. Time must be allowed for the pulping reaction to progress to the center of the chip. Before the reaction can reach the center of the chip the driving force for the reaction, the active alkali, has been almost exhausted. From then on, screened yields decrease in spite of the fact that screenings are still being converted to screened pulp. In the case of chips of small cross section, screenings have been reduced to practically zero in 1.5 hr. and there is no point in further cooking.

A comparison of yield data for steamed versus unsteamed chips shows that the steamed chips produced pulps with 2 to 3% lower yields, both total and screened. A good portion of this difference is caused by the fact that more than half of the material removed by steaming consisted of pentosan not readily removed by regular cooking. A study of the screenings data show that screenings content of pulps produced from steamed chips is reduced with considerably higher rapidity than from unsteamed chips. This is undoubtedly caused by the broomed-out, somewhat porous nature of the material resulting from steaming.

It is quite noticeable that there is very little difference in rate of pulping in the size ranges between 4 and 10 mesh. Values were so similar that the use of average yield figures seemed justified over this size range. Table IV is a compilation of these averages for total and screened yield of pulps produced from unsteamed chips, while Table V is a similar table for steamed chips. Per cent deviation of each mesh size from the average is included. The small numerical value of these deviations indicates that the use of such averages is justified.

These average values make it possible to show clearly how the rate of pulping reaction is changed by mechanical treatment. Figure 2 is a plot of per cent wood

Table V. Deviation of Yield Values from the Average
Chips Steamed Before Hammer-Milling

Cooking time, hr.	*Average yield for 4, 6, and 8-mesh chips, % of orig. wood*	*Deviation from average, %*				
		4 mesh	*6 mesh*	*8 mesh*	*10 mesh*	*16 mesh*
	Total yield[a] (Per Cent of Original Wood)					
1.0	54.6	+1.1	−0.6	−0.7	−2.4	−1.6
1.5	46.8	+0.9	+0.9	−2.0	−3.2	...
2.0	44.3	+0.5	0.0	−0.2	−2.9	−5.0
2.5	43.0	+0.9	0.0	−1.2	0.0	−4.2
3.0	42.5	+1.6	−0.2	−1.2	−0.9	−5.4
3.5	42.1	+0.2	−0.5	−0.2	...	...
	Screened yield[a] (Per Cent of Original Wood)					
1.0	13.6	+11.8	−12.5	0.0	+34.7	0.0
1.5	46.5	+1.3	+0.4	−1.7	−3.9	...
2.0	44.3	0.0	0.0	−0.2	−3.0	−5.2
2.5	42.9	+0.9	+0.2	−0.9	−0.2	−4.0
3.0	42.5	+1.6	−0.2	−1.2	−0.9	−5.9
3.5	42.1	+0.2	+0.2	−0.2	...	...

[a] Yield values are computed as per cent of original wood before steaming the chips.

Table VI. Strength Values for All Pulps

Chip size	Cooking time, hr.	Freeness orig. pulp, ml.	Beating time, 15 min. C.S. freeness, ml.	Tear factor	Breaking length, meters	Burst factor	Double folds	Beating time, 30 min. C.S. freeness, ml.	Tear factor	Breaking length, meters	Burst factor	Double folds	Beating time, 45 min. C.S. freeness, ml.	Tear factor	Breaking length, meters	Burst factor	Double folds
3/4-in. mill chips	1.5	763	720	199	6570	41.0	285	646	168	8020	53.7	450	482	140	9,000	60.2	596
	2.0	735	700	191	7700	49.0	478	578	159	9160	60.8	655	313	65	9,820	67.7	837
Mill Chips, Hammer-Milled, Dry and Screened																	
4 mesh	1.5	753	720	190	6930	40.3	364	647	161	8240	51.1	560	450	138	9,080	58.0	712
	2.0	743	707	170	7750	41.3	430	574	142	9200	53.2	715	305	123	10,030	60.6	920
6 mesh	1.5	760	750	197	6080	36.0	283	680	169	7470	46.7	430	590	144	8,620	53.7	554
	2.0	754	718	173	7130	42.8	423	557	146	8780	55.3	678	297	127	9,600	63.5	936
8 mesh	1.5	745	710	182	7150	41.3	305	545	152	8990	55.0	568	280	121	10,100	61.0	675
	2.0	764	713	173	7670	44.8	395	470	141	9290	56.0	673	198	119	10,070	61.6	882
10 mesh	1.5	750	736	162	7280	40.0	265	617	137	8550	51.0	450	295	116	9,320	57.3	633
	2.0	770	702	154	7540	38.6	303	496	133	8930	49.4	575	217	113	9,760	55.6	793
Mill Chips, Steamed 10 Min. at 170 P.s.i., Hammer-Milled, Dried, and Screened																	
4 mesh	1.5	755	725	216	6980	46.5	550	593	175	8400	56.5	857	335	142	9,250	62.4	1145
	2.0	724	700	192	7460	46.5	748	517	159	8820	56.4	983	267	131	9,580	60.5	1210
6 mesh	1.5	720	680	226	6830	40.6	457	596	173	8160	52.3	685	374	146	8,940	56.6	913
	2.0	718	673	200	7110	44.6	473	532	167	8530	55.3	767	297	140	9,350	59.8	1300
8 mesh	1.5	756	727	214	7130	39.3	435	607	173	8430	51.3	683	387	143	9,260	59.4	878
	2.0	760	718	191	7350	45.8	446	532	157	8700	55.4	710	282	131	9,400	60.3	1188
10 mesh	1.5	737	693	171	7220	41.5	265	580	141	8600	52.1	490	314	119	9,500	58.8	710
	2.0	750	682	156	7500	43.7	533	516	127	8890	57.2	746	263	108	9,700	62.7	1033
16 mesh	1.5	742	647	126	7130	41.0	410	285	101	8460	49.5	783	79	74	9,220	54.0	1150
	2.0	730	668	123	6580	41.9	276	533	101	8410	49.9	493	270	86	9,300	53.8	916

removed and per cent screened yield versus cooking time. The effect of steaming on rate of total wood removal is quite noticeable. However, the effect of presteaming on the production of screened pulp is very slight. The advantages of increased yield of screened pulp and decreased cooking time by mechanical reduction of chip size can be seen very clearly in the figure.

Approximately 24% more of the unsteamed hammer-milled chips than regular chips may be charged into a commercial vertical digester. The nature of the hammer-milled material is such that it is quite doubtful that any plugging effect will be realized if this type material is used. What effect this increased loading of the digester will have on liquor circulation, however, is an unknown factor.

If steamed hammer-milled chips instead of regular mill chips are charged into a standard vertical digester, a 23% decrease in material charged will be realized. This reversal in digester capacity is caused by the broomed-out, porous nature of the steamed chips.

Effect of Chip Size on Chemical Analysis of Pulps

Decrease in chip size seems to have no significant effect on the lignin content of pulps. Size reduction of chips without steaming has no effect on pentosan content while size reduction after steaming causes a decrease in pentosan content. This decrease in pentosans can be accounted for by the pentosan loss incurred by steaming the chips.

Size reduction without steaming has no effect on permanganate number of pulps. Size reduction with presteaming results in a very definite reduction in permanganate number. These chemical effects are clearly shown in Table II.

Effect of Chip Size on Physical Strength of Pulps

Physical strengths were evaluated for all pulps produced in 1.5 and 2.0 hr. cooking time. Tear and burst factors, breaking length and double fold values were determined for beating times of 0, 15, 30, 45, and 60 min. The data for beating times of 15, 30, and 45 min. are presented in Table VI. A graphical representation (not included here) of all of these factors plotted against beating time was prepared for each pulp. Direct comparison of one chart to another was then made.

Comparison of the strength data for pulps made from chips hammer-milled without steaming resulted in the following observations. For chip sizes of 4, 6, and 8 mesh, the curves of tear, burst, and breaking length showed remarkable agreement. The curves for double folds were rather erratic as would be expected but showed the same trend toward similarity. The strength curves for 10 mesh showed a slight decrease from the 4, 6, and 8-mesh values, while the 16-mesh values were definitely poor.

The pulps produced from chips which had been steamed before hammer-milling showed the same strength characteristics as described above. The strength factors for 4, 6, and 8 mesh were almost identical; 10 mesh were somewhat lower while 16 mesh were definitely low.

It was decided to average the strength values for the 4, 6, and 8-mesh material using separate averages for the steamed and unsteamed material. Even though the burst and breaking length values were similar for steamed and unsteamed wood, the steamed wood showed definite superiority in tear and double folds over the unsteamed wood. These average values, with maximum deviation, are presented in Table VII. It can be seen that the deviations are remarkably small in the cases of burst, tear, and breaking length while the deviations in double folds are understandably high.

The data from Table VII are plotted in Fig. 3 for pulps produced in 1.5 hr. cooking time. Included in the plot, showed as solid lines, are the strength data resulting from pulping of full-size mill chips. The figure shows that the steamed hammer-milled chips produce pulps definitely superior in tear to regular chips while hammer-milling without steaming results in tear values slightly inferior to unmilled chips. Tear values for 10 and 16-mesh material are also included showing that reduction to such small sizes will very definitely damage the tearing strength of the pulp.

Burst and breaking length do not appear to be changed appreciably by milling. In double folds,

Table VII. Average Strength Values of Pulps Produced from Chips of 4, 6, and 8-Mesh Size

Chip treatment	Cooking time, hr.	Beating time, min.	Av. C.S. freeness, ml.	Tear factor		Breaking length		Burst factor		Double folds	
				Av. value	Max. deviation from mean, %	Av. value	Max. deviation from mean, %	Av. value	Max. deviation from mean, %	Av. value	Max. deviation from mean, %
Mill chips, hammer-milled, dry, screened	1.5	0	753	219	3.2	4,530	2.9	19.8	4.0	63	37.5
		15	727	190	4.2	6,720	9.5	39.2	8.2	317	14.8
		30	624	161	5.6	8,230	9.2	50.9	8.3	519	17.1
		45	440	134	9.7	9,270	9.0	57.6	6.8	647	14.4
		60	204	113	13.2	9,950	7.1	61.4	4.2	851	22.7
	2.0	0	754	227	5.7	4,280	6.5	20.8	3.4	48	14.6
		15	713	172	1.8	7,520	5.2	43.0	4.2	416	5.0
		30	534	143	2.1	9,090	2.3	54.8	2.2	689	3.8
		45	267	123	3.5	9,900	3.0	61.9	2.3	913	3.4
		60	94	107	8.3	10,320	3.4	66.3	4.2	1098	8.8
Mill chips steamed 10 min. at 170 p.s.i., hammer-milled, dried, and screened	1.5	0	744	247	8.9	4,050	8.6	18.2	4.4	42	31.0
		15	711	219	3.2	6,980	2.1	42.1	10.4	481	14.4
		30	599	174	0.6	8,330	2.0	53.4	5.8	742	15.5
		45	365	144	1.4	9,150	2.3	59.5	4.9	979	17.0
		60	178	124	3.2	9,673	2.5	63.6	5.7	1211	18.9
	2.0	0	734	234	2.1	3,767	1.8	18.3	6.6	43	39.5
		15	697	194	3.1	7,307	2.7	45.6	2.0	556	34.7
		30	527	161	3.7	8,683	1.8	55.7	1.3	820	19.9
		45	282	134	4.5	9,443	1.4	60.2	0.7	1063	13.8
		60	116	114	3.5	9,907	0.9	62.2	1.1	1305	6.3

however, steaming and hammer-milling the chips prior to cooking definitely increases the double folds. The superiority indicated for dry hammer-milled chips over regular chips cannot be considered significant in view of the nature of the double fold test itself.

Figure 4 is similar to Fig. 3 except pulps were cooked 2.0 hr. instead of 1.5 hr. Here the superiority of steamed hammer-milled chips in tear and double folds can be seen to diminish but, in general, the two figures bring out the same points of comparison.

A comparison of the strength values in Figs. 3 and 4 shows the trends to be expected. Increased cooking time reduces the tear but the burst, breaking length, and double-fold values are increased somewhat.

From an over-all consideration of physical strength the data definitely show that chips can be reduced in size and their surface areas can be increased without serious damage to physical strength. In fact, if the chips are softened prior to hammer-milling, some strength increases can be expected. This is contrary to accepted belief that small chips will result in poor strength. It must be borne in mind that the small size chips under consideration are small in cross section across the grain while the chip length in the grain direction has not been decreased.

Effect of Chip Size on Mill Operation

It appears that mill production might be greatly increased with decreased wood cost by use of hammer-milled, unsteamed chips. Capacity in cords of wood per digester can be increased by 24% if chips are hammer-milled without steaming. Screened yields may be increased from 43.4% to about 50% with a reduction of 1.0 hr. in a 2.5-hr. cooking cycle. Only minor decreases in tearing strength of resultant pulps should result.

In these days of high-yield pulps and hot refining even further increases in capacity might result. The 50% screened yield mentioned in the preceding paragraph involved pulping to the point where screenings were negligible. Even higher yields will be realized if the cooking cycle is shortened even more. The raw condition of the pulp can be taken care of by hot refining.

On the other side of this optimistic picture is the unknown factor of liquor circulation in the digester when small cross-section chips are charged. This question can be readily answered by experimentation in any of the semicommercial size vertical digesters available for such work.

Another deterrent to hammer-milling of chips prior to pulping involves the losses, in the form of fines, entailed in mechanical treatment. Further study of size and shape of hammer-mill discharge screens, shape of hammers, etc., will undoubtedly reduce this production of fines to a very small percentage. Cost of milling should be a minor factor due to the extremely short retention time of chips in the mill.

Steaming and hammer-milling of chips prior to pulping offer no attractions to present mill operations where vertical digesters are used. Capacity of digesters, in cords of wood, will be decreased to about 77% of present capacity. Yield will be increased and cooking time will be decreased to almost the same extent as when untreated chips are milled. Strength of resultant pulps should be slightly improved. However, an additional steaming operation under pressure would be necessary.

The real application of hammer-milling steamed chips before pulping comes in the field of continuous cooking. Here, the highly porous nature of the chip makes very high reaction rates without cellulose degradation a feasible accomplishment. The data presented in this paper should indicate that the mechanical treatment of the chips, if carefully carried out, need not detract at all from the papermaking potential of the original wood.

LITERATURE CITED

1. Nolan, W. J., Harvin, R. L., Reeder, L. M., and Rothrock, C. W., Jr., *Tappi* 34, No. 17: 529–538 (Dec., 1951).
2. Cable, D. E., McKee, R. H., and Simmons, R. H., *Paper Trade J.* 83, No. 14: 47–49 (Sept. 30, 1936).
3. Chesley, K. G., and Robertson, N. F., *Paper Trade J.* 118, No. 20: 38–42 (May 18, 1944).
4. Suttle, Bruce, *Paper Trade J.* 118, No. 22: 110 (June 1, 1944).
5. Robertson, N. F., *Southern Pulp Paper J.* 7, No. 7: 28 (Dec., 1944).
6. Harvin, R. L., Hills, G. B., Jr., Rothrock, C. W., and Nolan, W. J., *Tappi* 33, No. 7: 338–343 (July, 1950).

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ASSOCIATION NEWS AND EVENTS

TAPPI Fall and Winter Meetings

Southeastern Section, Charter Meeting, King & Prince Hotel Brunswick, Ga., Sept. 19, 1952.

New England Section, Berkshire Inn, Great Barrington, Mass., Oct. 10–11, 1952.

Engineering Conference, Morrison Hotel, Chicago, Ill., Oct. 13–16, 1952.

Fibrous Agricultural Residues Conference (Strawboard), Northern Regional Research Laboratory, Peoria, Ill., Oct. 27–28, 1952 (Rooms at Pere Marquette Hotel).

Plastics Conference, Marshall Hall, College of Forestry, State University of New York, Syracuse, N. Y., Nov. 5–6, 1952 (Rooms at Syracuse and Onondaga Hotel).

Alkaline Pulping Conference, Battle House, Mobile, Ala., Nov. 12–14, 1952.

Corrugated Containers Conference, Schroeder Hotel, Milwaukee, Wis., Nov. 20–21, 1952.

Kalamazoo Valley Section, Hotel Harris, Kalamazoo, Mich., Jan. 15, 1953. Joint Meeting with the Michigan Division, American Pulp and Paper Mill Superintendents Assn.

Technical Section, Canadian Pulp & Paper Assn., Mount Royal Hotel, Montreal, P. Q., Jan. 28–30, 1953.

TAPPI Annual Meeting, Commodore Hotel, New York, N. Y., Feb. 16–19, 1953.

Packaging Evaluation and Development

To expand the scope of the TAPPI Container Testing Committee it has been transferred from the Testing Division to the Converting and Consuming Division.

The name of the committee has been changed to Packaging Evaluation and Development Committee. Charles A. Krebs, Atlas Boxmakers, Inc., Chicago, Ill., and C. Stewart Macnair, Acme Steel Co., Chicago, Ill., are Chairman and Secretary, respectively, of the committee.

The Packaging Evaluation and Development Committee will hold its first meeting at the Bismark Hotel, Chicago, Ill., on Oct. 15, 1952, at 2 p.m.

The scope of the committee has been defined as follows: "Nomenclature, definition of terms, test methods, performance specifications, and study of the effect of various factors influencing strength and serviceability relating to packaging, including packages, shipping containers and pallets, and the physical methods of testing container boards."

Since an important part of the work of this committee will result in the establishment of TAPPI Standards, it is expected that a Testing Methods Subcommittee will be organized for the purpose of preparing such procedures in TAPPI format. This subcommittee will later assume full committee status as the Container Testing Committee in the Testing Division.

TAPPI Research Projects

Currently, the Technical Association is financing a number of research projects for the benefit of several Association committees.

Following is a list of committee projects now being financed by means of TAPPI research grants:

R.P. 26. Chemical Methods Committee: "Cellulose Viscosity Methods."

R.P. 28. Acid Pulping Committee: "Properties of Ammonium and Magnesium Bisulphite Solutions."

R.P. 30. Fundamental Research Committee: "A Study of the Sugars Obtained by Hydrolyzing the Skin-Like Substance Obtained as an Insoluble Residue by Treatment of Pulp Fibers with Cuprammonium Hydroxide."

R.P. 31. Fundamental Research Committee: "Evaluation of the Dye Adsorption Method of Determining the External Specific Surface of Pulp."

R.P. 32. Structural Fibrous Materials Committee: "Determination of the Effect of Rate of Loading in the Flexural Resistance and Deflection of Fiberboard Test."

R.P. 33. Structural Fibrous Materials Committee: "Determination of a Method of Test for the Racking Strength of Insulating Board Sheathing."

R.P. 35. Structural Fibrous Materials Committee: "The Construction and Testing of a Test Board Forming Machine for Insulating Board."

R.P. 36. Chemical Engineering Committee: "Analysis of Data on Corrosion of Digesters in Kraft and Soda Mills."

R.P. 37. Hydraulics Committee: "Friction Loss of Paper Stock in Pipes."

R.P. 40. Water Committee: "Development of a Standard Method for the Determination of Suspended Solids in Mill Waste. A Comparison of Buchner vs. Gooch Methods."

R.P. 41. Structural Fibrous Materials Committee: "The Construction and Testing of Two Drainage Time Testers of New Design."

R.P. 42. Structural Fibrous Materials Committee: "The Purchase, Alteration and Evaluation of a Baumgartner Sphere for the Measurement of the Light Reflection from Insulating Board Finishes and Coatings."

R.P. 43. Fibrous Materials Testing Committee: "Species Identification of Wood and Wood Fibers. Coding of 150 to 200 North American Woods."

These projects are being financed by funds of the Technical Association of the Pulp and Paper Industry. The grants range from $1000 to $5000 or more. The work is being carried on in universities, government laboratories, and in paper mills where special facilities exist. The projects originate in the committees of the Association and are related to their major projects. When the need exists a committee can prepare a research appropriation request in accordance with prescribed procedure. This is submitted to the Research Appropriations Committee which is made up of Association members who are highly qualified to pass upon the merit of each request.

Seventh Engineering Conference

The TAPPI Engineering Conference will be held at the Morrison Hotel, Chicago, Ill., on Oct. 13–16, 1952. The following is the final program:

Program of Monday, October 13

8:30 a.m. REGISTRATION (*Mural Floor Foyer*)

9:15 a.m. GENERAL SESSION (*Mural Room*)

C. J. SIBLER, West Virginia Pulp & Paper Co., New York, N. Y., *General Chairman*

ADDRESSES OF WELCOME

9:30 a.m. MATERIALS HANDLING SESSION (*Mural Room*)

A. P. SCHNYDER, Ebasco Services, Inc., New York, N. Y., *Chairman*

1. "Pulpwood Felling, Preparation and Transportation from the Forest," by James E. Holecamp, Logging Engineer, American Pulpwood Assn., New York, N. Y.

11:15 a.m. Mill Maintenance and Materials Session (*Mural Room*)

H. F. Parker, New York & Pennsylvania Co., Lock Haven, Pa. *Chairman*

2. "Care and Maintenance of Rubber Covered Rolls in the Pulp and Paper Industry," by L. E. Lockman, U. S. Rubber Co., Providence, R. I.
3. "Engineer's Approach to Safety," by George Harper, University of Illinois, Urbana, Ill.

12:30 p.m. Engineering Division Business Luncheons
Steam and Power Committee (*Parlor B*)
Drying and Ventilating Committee (*Parlor D*)
Engineering Research and Machine Design Committee (*Walnut Room*)
Mill Maintenance and Materials Committee (*Parlor C*)

2:00 p.m. Drying and Ventilating Session (*Mural Room*)

M. L. Barker, Beckett Paper Co., Hamilton, Ohio, *Chairman*

4. "An Evaluation of Drying Concepts," by W. H. Funk, Lukens Steel Co., Coatesville, Pa.
5. "Follow the Rules for Proper Steam Blast Coil Installation and Avoid Costly Trouble," by R. G. Lubinsky, The Trane Co., La Crosse, Wis.

3:30 p.m. Discussion Sessions

Materials Handling (*Mural Room*)

6. "Harvesting and Handling of Smaller Sizes of Pulpwood from the Forest to the Wood Yard." Discussion Leader: W. A. McKenzie, Simpson Logging Co., Shelton, Wash.

Mill Maintenance and Materials (*Casino*)

7. "The Tool Room vs. the Store Room for Maintenance Tools", R. Q. Connor, Crossett Paper Co., Crossett, Ark., Discussion Leader.

Drying and Ventilating (*Roosevelt Room*)

8. Discussion of Session Papers

6:30 p.m. Dinner (Where You Will)

Program of Tuesday, October 14

9:00 a.m. Steam and Power Session (*Mural Room*)

H. R. Arnold, Riegel Carolina Corp., Acme, N. C., *Chairman*

9. "The Combination of Hot Zeolite Softening of Boiler Feedwater," by J. D. Yoder, Permutit Co., New York, N. Y.
10. "Application of the Package Steam Generating Unit to the Paper Industry," by Frank X. Gilg, The Babcock & Wilcox Co., New York, N. Y.

10:30 a.m. Mill Design and Economic Aspects Session (*Mural Room*)

Roland A. Packard, Mutual Security Administration, Washington, D. C., *Chairman*

11. "Government and the Pulp and Paper Industry in the United States," by Allan Hyer, Bagley & Sewall Co., Watertown, N. Y.

12:30 p.m. Engineering Division Business Luncheons
Materials Handling Committee (*Parlor B*)
Mill Design and Economic Aspects Committee (*Parlor F*)
Hydraulics Committee (*Parlor D*)
Electrical Engineering Committee (*Parlor C*)
Chemical Engineering Committee (*Walnut Room*)

2:00 p.m. Chemical Engineering Session (*Mural Room*)

J. R. Lientz, Union Bag & Paper Co., Savannah, Ga., *Chairman*

12. "Digester Corrosion Measurement," by Nicholas Shoumatoff, West Virginia Pulp & Paper Co., New York, N. Y.
13. Summary of Battelle Memorial Institute's Special Report on "Analysis of Corrosion Questionnaires"
14. "Corrosion in Action," a motion picture presented by the International Nickel Co., New York, N. Y.

3:30 p.m. Discussion Sessions

Mill Design and Economic Aspects (*Casino*)

15. "Report on Visit to Far East," by Roland A. Packard, Mutual Security Agency, Washington, D. C.

Steam and Power (*Mural Room*)

16. "Electrical Problems When Operating in Parallel with a Utility." Discussion Leader: D. F. Langenwalter, General Electric Co., Schenectady, N. Y.

Chemical Engineering (*Roosevelt Room*)

17. Discussion of Meeting Papers and Data Sheet on Digester Corrosion Inspection

6:00 p.m. Get-Together Party and Smorgasbord (*Monte Carlo and Casino*) (Sponsored by Allied Industries)

Program of Wednesday, October 15

9:00 a.m. Electrical Engineering Session (*Mural Room*)

R. W. Foster, Champion Paper & Fiber Co., Canton, N. C., *Chairman*

18. "Application of Electric Cables," Progress Report by A. O. Mortenson, St. Regis Paper Co., Cantonment, Fla.
19. "Power Requirements for Press Sections," by R. R. Baker, Westinghouse Electric Corp., East Pittsburgh, Pa.
19a. "Power Requirements for Chippers," by M. J. Osborne, Bowaters Southern Paper Corp., Calhoun, Tenn.

10:30 a.m. Hydraulics Session (*Mural Room*)

K. J. Mackenzie, Eastman Kodak Co., Rochester, N. Y., *Chairman*

20. "Correlation Between Shear Criterion and Pipe Friction Loss," Progress Report by R. E. Durst, University of Maine, Orono, Me.

12:30 p.m. Engineering Division Luncheon (*Mural Room*)

C. J. Sibler, West Virginia Pulp & Paper Co., New York, N. Y., *Chairman*

21. *Address:* "People Have a Place in Your Planning," by A. J. Miller, Jr., Assistant Director of Industrial Relations, Mead Corp., Chillicothe, Ohio

2:30 p.m. Engineering Research and Machine Design Session (*Mural Room*)

J. D. Lyall, Armstrong Cork Co., Lancaster, Pa., *Chairman*

22. "Flow in Converging Nozzle-Type Slices—Can Negative Pressures Be Present?" by J. B. Gough, Consultant, Mead Corp., Chillicothe, Ohio.
23. "A Method of Determining Sheet Making Rates in Cylinder Machine Operation," by Charles F. Payne, Eastman Kodak Co., Rochester, N. Y.
24. "An Analysis of a Cylinder Vat," by J. A. Jackson, St. Regis Kraft Co., Jacksonville, Fla.

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3:45 p.m. Discussion Sessions
Electrical Engineering (*Mural Room*)

25. "Power Requirements of Supercalenders," by J. L. Van Nort, Reliance Electric & Engineering Co., Cleveland, Ohio

Hydraulics (*Casino*)

26. "Discussion of University of Maine Project on Pipe Friction Loss"

Engineering Research and Machine Design (*Roosevelt Room*)

27. Discussion of Session Papers
28. Discussion of Project on "Estimating Costs of Engineering Projects"

7:00 p.m. Dinner Meeting for Committee Chairmen and Secretaries (*Suite 440*)

Review of 7th Engineering Conference
Discussion of Plans for 8th Engineering Conference to be held at the King Edward Hotel, Toronto, Ont.
Discussion of Engineering Division Projects
TAPPI Data Sheets

Program of Thursday, October 16

9:00 a.m. Plant Visits

Arrangements are being made to visit the plants of the Crane Co., Link-Belt Co., and the Inland Steel Co.

Local Section Meetings

Kalamazoo Valley

The next meeting of the Kalamazoo Valley Section will be held at the Harris Hotel, Kalamazoo, Mich., on Oct. 2, 1952. There will be a panel discussion of "Management's View of the Technical Department." Six local mill executives will participate as members of the panel. Future meetings of the Section will be held at the Harris Hotel on Nov. 6, 1952, Dec. 4, 1952, Jan. 15, 1953, Feb. 5, 1953, March 19, 1953, April 2, 1953, May 7, 1953, and June, 1953. The meeting on Jan. 15, 1953, will be the large community meeting sponsored jointly by the Section and the Michigan Div. of the Superintendents' Assn.

New England

The Fall meeting of the New England Section will be held at the Berkshire Inn, Great Barrington, Mass., October 10–11, 1952.

Southeastern

Future meetings of the Southeastern Section will be held in November at Jacksonville, Fla., Jan. 23, 1953, at Charleston, S. C., March 20, 1953, at the Hotel Dempsey, Macon, Ga., and May 8, 1953, at the De Soto Hotel, Savannah, Ga.

Delaware Valley

The Delaware Valley Section will meet at the Engineers Club, Spruce St., Philadelphia, Pa., on Oct. 23, 1952 (Paper and Printing); Dec. 4, 1952 (Management); Jan. 22, 1953 (Development of Paper Properties); March 26, 1953 (Engineering); April 23, 1953 (Paper Defects); and May 28, 1953 (The Edward J. Albert Award Presentation Meeting).

Maine-New Hampshire

The Fall meeting of the Maine-New Hampshire Section will be held at the Lafayette Hotel, Portland, Me., on Nov. 7–8, 1952.

The subject of the meeting will be "Bleaching of Chemical Pulps," with formal papers presented on Friday afternoon, November 7. On Saturday morning there will be a tour of inspection of the new bleaching plant of the S. D. Warren Co., Cumberland Mills, Me.

Ohio

The first meeting of the Ohio Section will be held at the Manchester Hotel, Middletown, Ohio, in September. Professor Karl Freudenberg of Heidelberg University, Heidelberg, Germany, will be the speaker. Dr. Freudenberg's subject will be "Lignin Chemistry." At the time of going to press the actual date of the meeting was not announced.

On October 14 J. A. Van den Akker of The Institute of Paper Chemistry will speak on "Measurement of Color" (Manchester Hotel).

The November 18 meeting will be held at the Manchester Hotel, jointly with the Miami Valley Div. of the Superintendents' Assn. The subject will be "Electrical Distribution Systems in Paper Mills."

Empire State (Metropolitan)

The First meeting of the Metropolitan District of the Empire State Section will be held at Fraunces Tavern, New York, N. Y. on October 14th.

Plastics Conference

The TAPPI Plastics Conference will be held at the College of Forestry, Syracuse, N. Y., on Nov. 5–6, 1952. To date the following papers have been scheduled:

"Recent Improvements on the Morphology of Cellulose Fibers and Their Significance for Fiber to Resin Bonding," by Bengt Ranby, Uppsala University, Uppsala, Sweden.
"Recent Improvements in Measuring Adhesion and Their Application to Fiber to Resin Bonding," by H. Mark, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.
"A Melamine-Type Resin for Beater Addition Process to Form Laminated Sheet or Molding Preforms."
"Abrasion Testing on Decorative Laminates with the Armstrong Abrader."
"Principles of Performance Testing of Polyester Coating," by Russell Dean, Interchemical Corp., New York, N. Y.

Fibrous Agricultural Residues Conference

The Fibrous Agricultural Residues Conference will be held at the Northern Regional Research Laboratory, Peoria, Ill., on Oct. 27–28, 1952.

The subject of the conference will be "Straw Specifications and Grading." The forum of the meeting will be a round-table discussion based on questions received from members of the committee on phases of straw procurement and quality.

It is expected that specialists of the U. S. Department of Agriculture on specifications and grading of hay and straw will be present and enter into the discussions.

RECENT BOOKS

Australian Pulp & Paper Technical Association. Proceedings 1951, Vol. 5. Published by APPITA, South Melbourne, Victoria, Australia. Cloth, $5^1/_2 \times 8^1/_2$, 343 pages. $8.

The papers presented in 1951 at meetings of the APPITA, including such subjects as Roll Cambering, Ideal Drier System, Paper Finishing Operations, Converting Trends, The Morden Stockmaker, Wallboard Pulp Properties, Clarification of Effluent, Eucalypt Groundwood, Cell Wall Studies, Lignin-Carbohydrate Bond, Reproducible Wood Sample, Influence of Extractives on Pulping.

Industrial Heat Transfer. By F. W. Hutchinson, Professor of Mechanical Engineering, Univ. of California, The Industrial Press, New York, 1952. Cloth, 6 × 9, 336 pages. $6.00.

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CURLATOR is the ONLY Mechanical Device that will produce from fine screen rejects

- ✓ A CLEANER PULP
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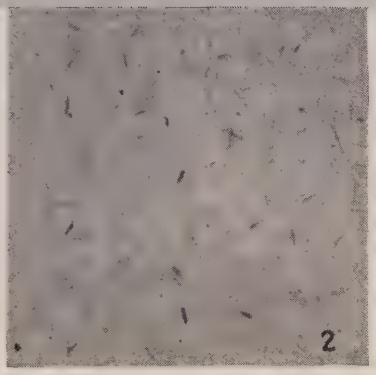
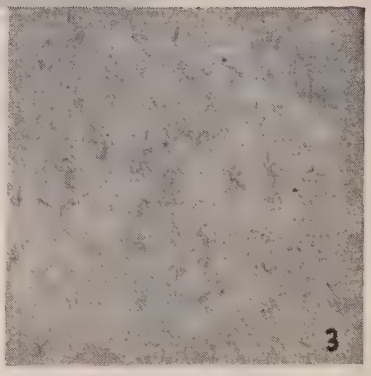
- ✓ WITHOUT AFFECTING FIBER LENGTH

SEE THE DIFFERENCE... These unretouched photographs are actual size.

Paper made with fine screen rejects. Note dirt, shives and large fiber bundles.



Paper made with rescreened rejects. Only the largest particles, 8% of the rejects, are removed. Note the large number of shives which passed through the screen.



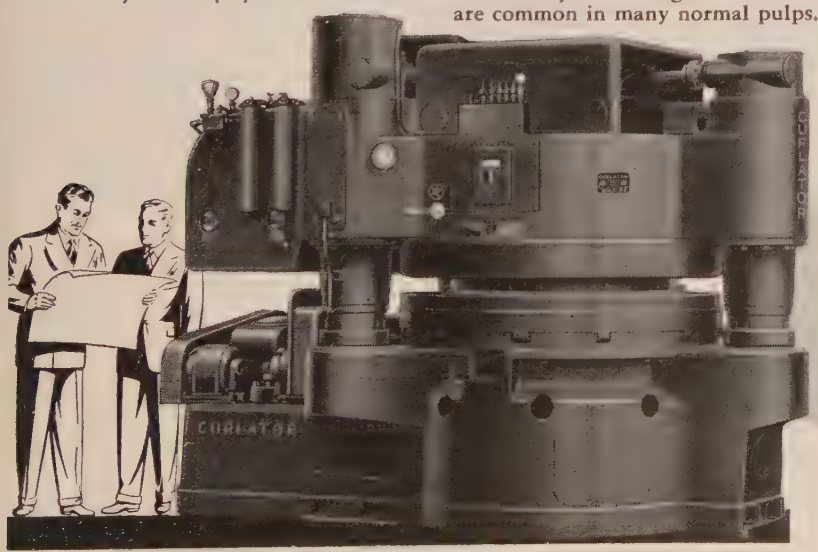
Paper made with screened, Curlated rejects. 99.4% of the fine screen rejects are in this sheet. Note improvement in cleanliness as a result of Curlation.

Write for more detailed information. See the results obtained from your own pulp.

Actual mill operation proves Curlation eliminates shives and separates the individual fiber bundles, as well as reducing the sizes of dirt particles. This permits a large portion of the dirt to be removed during washing and thickening operations.

Curlation increases yield by converting shives and fiber bundles into No. 1 pulp. With Curlation you no longer have No. 2 pulp and fine screen rejects. Increased yields of 5% are common in many normal pulps.

Curlation imparts a permanent bend and twist to fibers thereby imparting higher tearing strength to paper made from Curlated pulp. Sheet No. 3 has 60% higher tearing strength than sheet No. 2. Curlator patented action rolls fiber and fiber bundles under pressure without reducing fiber length. Curlation does not cut the fibers.



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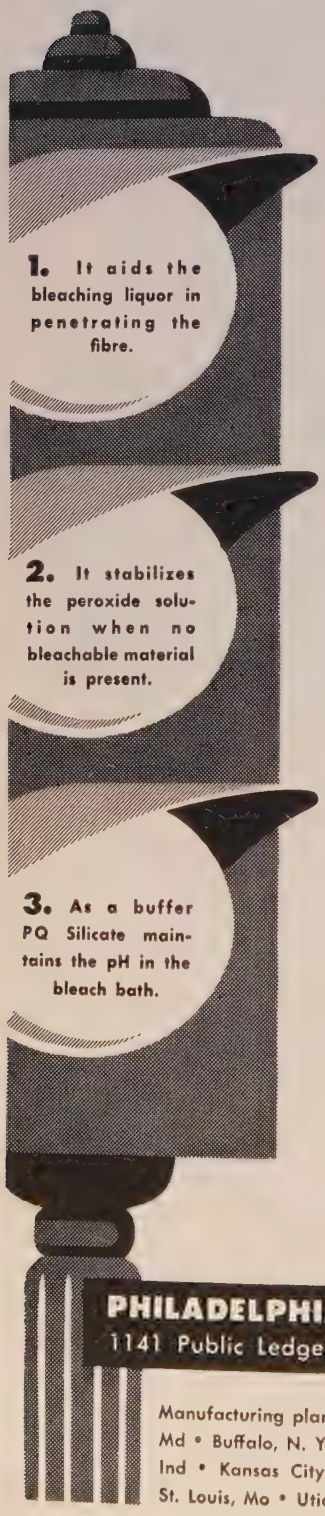
1. It aids the bleaching liquor in penetrating the fibre.
2. It stabilizes the peroxide solution when no bleachable material is present.
3. As a buffer PQ Silicate maintains the pH in the bleach bath.

Know the quality of the silicate which you use for stabilizing peroxide solutions. PQ Silicate's consistent uniformity helps to avoid wasting peroxide. It's a constant in your bleaching cycle that saves time and money.

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This is a combined text and reference book, featuring 123 working charts for the rapid and accurate evaluation of heat transfer coefficients and rates. It provides a selective, time-saving approach to methods of heat transfer analysis. Coverage in this volume includes conduction, radiation, convection, combined heat transfer, and forced convection. Emphasis throughout has been placed on those equations which find widest industrial application and which are of the greatest practical importance.

Measurement and Control of Temperatures in Industry. By R. Royds, Chemical Publishing Co., New York, 1952. Cloth, $5^1/_2 \times 8^1/_2$, 260 pages. $5.00.

This book covers the latest developments in several industries. Among the subjects covered are standard scales of temperature, electrical pyrometers, radiation, optical, and photoelectric pyrometers; and the measurement of rapidly fluctuating temperatures.

Glycols. Edited by George O. Curme, Jr., and Franklin Johnson, Carbide and Carbon Chemicals Co. Reinhold Publishing Co., New York, 1952. Cloth, $6 \times 9^1/_4$, 390 pages. $12.

American Chemical Society Monograph No. 114 deals with the production, physical properties, application, derivatives, condensation polymers, physical aspects, and analytical methods relating to glycols. It is the work of the members of the research staff of the Carbide and Carbon Chemicals Corp.

Graphic Aids in Engineering Computation. By Randolph P. Hoelscher and Stanley H. Pierce, Univ. of Illinois, and Joseph N. Arnold, Purdue Univ. McGraw-Hill Book Co., New York, 1952. Cloth, 6×9, 197 pages. $4.50.

Technology tends to simplify itself as more about any phase of it is known. Constant efforts are made to prepare bibliographies, digests, reviews, handbooks, encyclopedias, etc. This book performs the same service in showing how mathematical problems may be solved without performing the arduous computations needed in solving problems before their patterns were fully understood. The present volume presupposes a knowledge of mathematics through analytical geometry. It deals, in detail, with such subjects as the slide rule (standard and special), empirical equations from engineering data, alignment charts, graphical calculus, and movable scale nomographs.

Nomography and Empirical Equations. By Lee H. Johnson, Tulane Univ. John Wiley & Sons, Inc., New York, 1952. Cloth, 6×9, 150 pages. $3.75.

This book is a useful guide to quick, efficient methods for handling experimental and operational data in business, industry, professional practice, and research. Included are parallel scale nomographs, Z-charts, concurrent scales and recurrent variables, combined nomographs, methods of curve fitting, and curves of three and four constants.

Manufacture of Intermediates and Dyes. By G. H. Frank. Chemical Publishing Co., New York, 1952. Cloth, $5^1/_2 \times 8^1/_2$, 177 pages. $4.50.

The author has written a how and why book dealing with the manufacture of dyes, including the benzene, naphthalene, and the anthracene series of dyes. The plant equipment and testing methods used are described.

Note: Any book reviewed in *Tappi* may be obtained through the Book Dept., Technical Association of the Pulp and Paper Industry, 122 E. 42nd St., New York, 17, N. Y.

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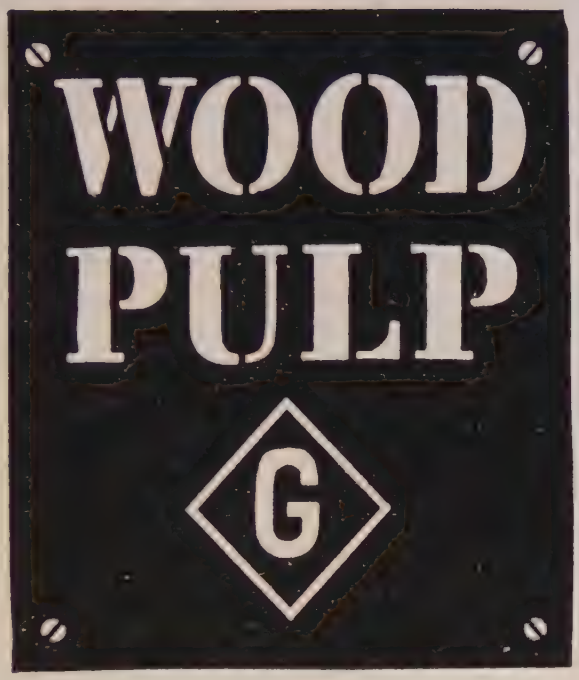

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PERSONAL MENTION

Items About New and Old Tappimen

New TAPPI Members

Alice M. Amoss, Librarian, Technical Library, Army Chemical Center, Md.

Hartley B. Arnold, Plant Engineer, Riegel Carolina Corp., Acma, N. C., a 1921 graduate of Wentworth Institute.

Clarence M. Ayres, Jr., Chief Engineer, Gulf States Paper Corp., Tuscaloosa, Tenn., a 1927 graduate of the University of Alabama.

Harrison P. Baldwin, Project Engineer, Hammermill Paper Co., Erie, Pa., a 1936 graduate of Cornell University.

Ray S. Bender, Sales Engineer, The Appleton Machine Co., Appleton, Wis.

Robert L. Buechler, Assistant Director, Research and Development, Crystal Tissue Co., Middletown, Ohio, a 1950 graduate of Purdue University.

George V. Caesar, Director of Research and Development, Starch Dept., The Huron Milling Co., Harbor Beach, Mich., a 1915 graduate of Yale University.

Thos. F. Cass, General Manager, Southern California Div., Container Corp. of America, Los Angeles, Calif. Attended Dartmouth College.

Frank A. Denison, Jr., District Manager, Reliance Electric & Engineering Co., Cleveland, Ohio, a 1936 graduate of the University of Michigan.

Franklin G. Doenges, Engineer, The Weston Paper & Mfg. Co., Terre Haute, Ind., a 1939 graduate of Rose Polytechnic Institute.

Royston Dunford, Director, Public Relations & Development, Lustre Fibres, Inc., New York, N. Y.

Charles M. Durkee, Sulphite Superintendent, Great Northern Paper Co., Millinocket, Me.

William S. Fields, Project Engineer, Armstrong Cork Co., Lancaster, Pa., a 1950 graduate of Carnegie Institute of Technology.

William Finnie, Chief Chemist, The Ault & Wiborg Co. of Canada Ltd., Toronto, Ont., Canada, a 1928 graduate of McGill University.

Angus J. Gardner, Vice-President, Rice Barton Corp., Worcester, Mass., a 1932 graduate of Northwestern University with a Post Graduate Degree from the University of Maine.

Donald M. Gilmore, Technical Trainee, Rhinelander Paper Co., Rhinelander, Wis., a 1952 graduate of the New York State College of Forestry.

Orland W. Grant, Project Engineer, John Waldron Corp., New Brunswick, N. J., a 1949 graduate of George Washington University.

Marion Leach, Librarian in Charge, Canadian Armament Research & Development Establishment, Quebec, P. Q., Canada, a 1939 graduate of the University of Toronto.

Lincoln M. Lenzi, Training Director, The Mead Corp., Chillicothe, Ohio, a 1941 graduate of DePaul University.

Doris M. Louis, Librarian, Pabco Products, Inc., Emeryville, Calif.

Alfred J. Moran, President, Thos. J. Moran's Sons, Inc., New Orleans, La., a 1938 graduate of Harvard Business School.

John E. Munroe, Plant Chemist, Portorican Paper Products, Inc., San Juan, Puerto Rico, a 1952 graduate of Xavier University.

Sadao Nakamura, Director of Manufacturing, Japan Monopoly Corp., Tokyo, Japan, a 1939 graduate of Tokyo Imperial University.

Isao Oonishi, Chief of Tobacco Research, Central Research Institute, Japan Monopoly Corp., Tokyo, Japan, a 1939 graduate of Tokyo Imperial University.

Hugh E. Ramsden, Research Chemist, Metal & Thermit Corp., Rahway, N. J., a 1946 graduate of Massachusetts Institute of Technology.

Gerhard Roesner, Managing Director, Lurgi Gessellschaft fur Chemie und Huttenwesen m.b.H., Frankfurt, Germany, a 1926 graduate of the Technical University, Breslau, with a Dr.Ing. degree.

Howard Rosen, Assistant Technical Director, National Container Corp., Long Island City, N. Y., a 1948 graduate of New York University.

Vincent A. Russo, Student, Institute of Paper Chemistry, Appleton, Wis., a 1952 graduate of Rensselaer Polytechnic Institute.

Hirochika Sakata, Head, Research on Pulp and Rayon Dept., The Textile Research Institute of Japanese Government, a 1933 graduate of Tokyo University.

Eleanor Stephens, Librarian, Oregon State Library, Salem, Ore.

Frank L. Strand, Research Chemist, U. S. Gypsum Co., Chicago, Ill., a 1948 graduate of Northwestern Technological Institute.

E. H. Stryker, Engineering Manager, Pabco Products, Inc., Emeryville, Calif., a 1942 graduate of the University of California.

Franklin O. Ware, Paper Sales, The Brown Co., Chicago, Ill., a 1949 graduate of Kalamazoo College.

Charles H. Weinman, Chief Chemist, American Decalcomania Co., Chicago, Ill., a 1934 graduate of the University of Vienna, with a Ph.D. degree.

Anthony A. Yankowski, Assistant to Groundwood and Paper Mill Superintendents, Coosa River Newsprint Co., Coosa Pines, Ala., a 1941 graduate of Purdue University.

Thomas G. Zentner, Chemist, Gardner Board & Carton Co., Middletown, Ohio, a 1948 graduate of Texas A & M College.

TAPPI Notes

Joseph E. Atchison, formerly of the Pulp and Paper Branch, Mutual Security Agency, is now Resident Manager, Portorican Paper Products, Inc., San Juan, Puerto Rico.

Berle B. Babler, formerly of the Atlanta Paper Co., is now Superintendent, Coatings and Laminating, Fleming & Sons, Dallas, Tex.

Leonard S. Baness, formerly of Gardner Board & Carton Co., is now Mechanical Engineer for the International Minerals & Chemicals Co., Chicago, Ill.

J. F. T. Berliner, Chemical Engineer and Consultant, has moved his offices from 539 S. Franklin St., to 2710 South Parkway, Chicago 16, Ill.

Thomas B. Calhoun, Sales Engineer for Oliver United Filters, Inc., has been transferred from New York City to P.O. Box 1518, Fairhope, Ala.

Philip A. Cerasoli, formerly Student at the N. Y. State

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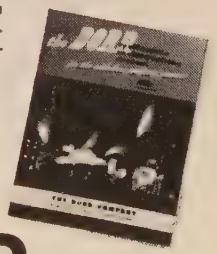
If you would like information about the newest equipment and techniques in continuous recausticizing, drop us a line and ask for a copy of Dorr Bulletin No. 3301.



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College of Forestry, is now with W. C. Hamilton & Sons, Miquon, Pa.

Charles H. Chapman, Sales Engineer of the Hercules Powder Co., has been transferred from San Francisco, Calif., to Holyoke, Mass.

Lawrence C. Crowder, formerly of Macon Kraft Co., is now Chief Engineer of Rome Kraft Co., Rome, Ga.

Warren J. Current, formerly of Fibreboard Products, Inc., is now Engineer for the Champion Paper & Fibre Co., Hamilton, Ohio.

Donald R. Darby, formerly of the Oregon Pulp & Paper Co., is now Draftsman for the Columbia River Paper Mills, Vancouver, Wash.

William P. Dohne, formerly of the Hawthorne Paper Co., is now Paper Chemist for the Dixie Cup Co., Easton, Pa.

Howard W. Duggan is now Vice-President in Charge of Engineering for Stebbins Engineering & Mfg. Co., Watertown, N. Y.

William M. Ebersole is now General Superintendent of the Macon Kraft Co., Macon, Ga.

Joseph Edwards is now Vice-President of Price Bros. & Co., Ltd., Kenogami, P. Q.

Henry W. Fales is now Vice-President and General Manager of the St. Croix Paper Co., Woodland, Me.

Pasquale A. Forni is now Chief of the Pulp and Paper Branch, Mutual Security Agency, Washington, D. C.

Allen H. Gridley, Engineer for the National Container Corp., has been transferred from Jacksonville, Fla., to Valdosta, Ga.

L. S. Hatch is now Manager of the Penobscot Chemical Fibre Co., Great Works, Me.

Olin Hyde, formerly Student at the N. Y. State College of Forestry, is now with the Champion Paper & Fibre Co., Canton, N. C.

Helen U. Kiely, formerly Technical Director, is now Consultant for the American Writing Paper Co., Holyoke, Mass.

John Maxson is now Secretary of Stebbins Engineering & Mfg. Co., Watertown, N. Y.

John M. McClure, formerly Student at the University of Maine, is now a Trainee with S. D. Warren Co., Cumberland Mills, Me.

E. P. McGinn, formerly Technical Editor of the *Paper Trade Journal*, is now Head of the Paper Div., Sandoz Chemical Works, Inc., Verona, N. J.

George D. McTeague, Technical Secretary of Cia. Industrias de Papel Pirahy has been transferred from Rio de Janeiro to Rio Grande do Sul, Brazil.

Robert W. Miller, Chemical Engineer for the Pacific Lumber Co., has been transferred from San Francisco to Scotia, Calif.

A. S. Quinn is now Vice-President of Stebbins Engineering & Mfg. Co., Seattle, Wash.

R. W. Reed is now Technical Director for the Rhinelander Paper Co., Rhinelander, Wis.

Carl F. Richter is now Chairman of the Board, Stebbins Engineering & Mfg. Co. Watertown, N. Y.

Kenneth R. Ross, formerly Student at Cornell University, is now Junior Engineer for Union Bag & Paper Corp., Savannah, Ga.

Frederick L. Schucker, formerly of the PMC Dept., Hercules Powder Co., is now Paper Research Chemist for Rohm & Haas Chemical Co., Philadelphia, Pa.

Donald H. Seixas, formerly of the American Can Co., is now Sales Representative, Pulp Div., Weyerhaeuser Timber Co., San Francisco, Calif.

L. R. Sherlock, formerly of Fir-Tex Insulating Board Co., is now Chief Chemist for Evan Products Co., Coos Bay, Ore.

Raymond W. Snyder, formerly Student, N. Y. State College of Forestry, is now Paper Inspector, Champion Paper & Fibre Co., Canton, N. C.

Harold Spector, formerly of the St. Regis Paper Co., is now Senior Paper Research Chemist for the Naugatuck Chemical Div., U. S. Rubber Co., Naugatuck, Conn.

Roger W. Strauss, formerly of Bauer Bros. Co., is now on the Research Staff of the Hammermill Paper Co., Erie, Pa.

L. V. Subba Rao, formerly of K. L. Ltd., is now Paper Technologist for the National Chemical Laboratory, Poona, India.

Beaumont Thomas is now Vice-President in Charge of Research of Stebbins Engineering & Mfg. Co., Watertown, N. Y.

Edward F. Tucker is now President of Stebbins Engineering & Mfg. Co., Watertown, Ohio.

Jan Unander-Scharin, formerly of Bowaters Sevenska Tramassefabriker A/B, is now Manager of Scharin & Co., Umea, Sweden.

William R. Zwecker, formerly Consulting Engineer, is now Plant Manager, Chippewa Paper Products Co., S. Hackensack, N. J.

* * *

John S. Brush, General Manager, has succeeded *Les J. Smith* as the official representative of the Gould Paper Co., Lyons Falls, N. Y.

Industry Notes

Pulp Imports

Receipts of wood pulp by the United States in the first six months of 1952, by country of origin are as follows (short tons): Sweden, 61,260, Finland, 9600, France, 119; Germany, 169; Switzerland, 90, and Canada and Mexico, 803,040.

The grades imported from Canada, Newfoundland, and Mexico are:

Bleached sulphite (paper-grade)	115,795
Bleached sulphite (nonpaper-grade)	94,168
Unbleached sulphite	175,041
Bleached sulphate	228,647
Unbleached sulphate	65,076
Groundwood (bleached)	10,516
Groundwood (unbleached)	94,794
Soda	14,545
Screenings	4,458
Total	803,040

Japan in Alaska

A Japanese government spokesman has stated that his government expects to submit a plan to the U. S. Government and private Japanese pulp and rayon manufacturers next month covering production of pulpwood in Alaska. This joint venture would involve a total capital of $20,000,000 to cover the cost of erecting a plant with a 100,000 ton annual producing capacity. A part of the plan would be the importation of the pulpwood into Japan for further processing.

B.t.u.-Basis Coal Buying

The rather widespread practice since World War II of purchasing coal on the "cents-per-million-B.t.u. basis" has faults which can react seriously to the disadvantage of both the purchaser and seller. It is true that the simplicity of the method appeals to both, and it is unfortunate that it does not reflect the true value of coals to a given plant.

If coals were perfect fuels, made up of 100% heating energy, with no impurities, or if coals were all alike in physical and chemical characteristics, the B.t.u. method for evaluation purposes would be practicable. On the other hand, if combustion equipment were perfect, and could burn all coals with equal facility, the method would also be practicable. Actually, however, coal is not a perfect fuel, nor is any combustion equipment perfect; therefore, everything is relative with respect to both coal and combustion equipment. Thus, perforce, proper fuel application falls entirely in the field of relativity.

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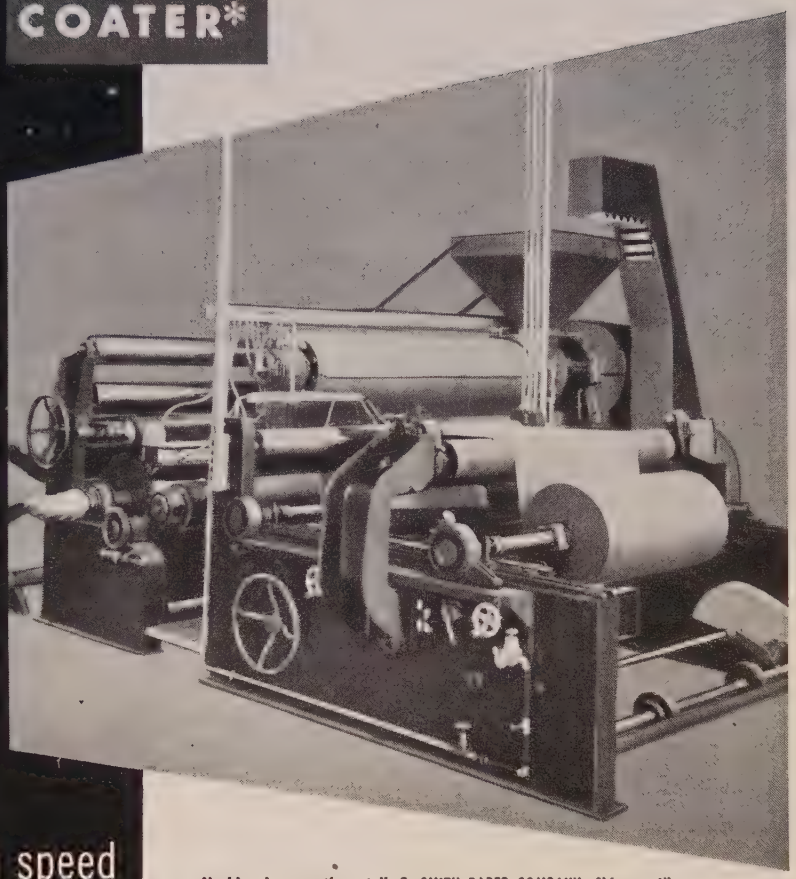
All controls are mounted in a special operator's control stand with the top panel inclined for ease of viewing and handling. Completely enclosed.



Machine in operation at H. P. SMITH PAPER COMPANY, Chicago, Ill.

Another in the series of Frank W. Egan & Company developments and installations, this is the latest Extrusion-type coater for applying polyethylene at speeds up to 1000 FEET PER MINUTE.

The polyethylene is extruded from a die and the extruded film is laminated to the paper between the nip of two rolls.

This coater incorporates automatic splicing unroll and reroll equipment for high speed operation.

*With Patented Features

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The B.t.u. unit basis of "cents-per-million" places a penalty on better coals, and a premium on poorer coals. It does not take into account the deleterious effect of the variable negative factors in coal, such as ash, moisture, sulphur, iron, fusion, and grindability. The cost per-million-B.t.u. of coal delivered to the track hopper of an industrial plant is only the *first* stage of the problem, and may be a totally unreliable measurement. It may be like buying a size No. 8 shoe for a size No. 12 foot. What a given coal will *do*, for a particular power plant in over-all performance and economy, is the real criterion.

The true value of a coal is apparent only after its energy has been converted into steam. In other words, what does the B.t.u. in the coal cost when measured at the steam outlet of the boiler, or at the turbine throttle? This question brings in a whole train of incremental costs, involving maintenance, coal-ash handling, boiler and furnace efficiency, labor, continuity of service, and certain other factors.

With respect to burning equipment, the average power plant today probably has equipment, some of which is old, some of medium age, and some new. It is no simple matter to purchase coal for such a plant. Certainly fuel cannot be intelligently selected for this plant on the "cents-per-million-B.t.u." basis, regardless of whether it is desired to find one coal to serve all three classes of equipment, or whether a separate coal is selected for each category. Even in the case of new boiler installations, it is rare to find one which can burn any or all types of coal available to the area, and if it had such facility it would be rare indeed if the coal delivered to the plant at the lowest B.t.u. cost would be the most economical fuel to use.

In other words, just because a boiler unit, due to technological and engineering advances, can be designed today to operate on the poorest fuel available, it would be most unusual if this happened to be the most economical fuel to use; nor does it necessarily follow that the very highest-quality coal available would prove to be the most economical.

Careful testing and evaluation of a dozen or more factors would be necessary to find the most suitable coal for such an installation. The incremental costs of using the poorest-grade coal could conceivably amount to $1.00 to $1.50 per ton. Following are some of the factors which affect coal selection:

1. It costs money to handle coal and ashes, and a greater tonnage of both must be handled as coal quality decreases.

2. The heating surfaces in all boilers, whether old or modern, become fouled in time. In most instances, more or less slag or dirt formation occurs in the furnace and tube banks reducing heat transfer and lowering combustion efficiency. Not only the ash-fusion temperature, but also the amount of ash in the coal, affects the rate of build-up of slag between cleaning intervals.

3. High moisture in coal is a troublesome factor, increasing coal-handling costs, creating difficulties in coal feeding and grinding, and requiring preheated air of higher temperatures.

4. Higher sulphur content brings corrosion problems, and in some instances these are of great magnitude, causing the rapid deterioration of metal surfaces—particularly in the heat-recovery apparatus, such as air heaters and economizers, as well as on breechings and stacks.

5. Ability to carry the load, not just for a day, nor for a week, but for month after month; and, incidentally, the elimination of costly maintenance and boiler outages is one of the primary requisites of any fuel.

6. Maintaining high boiler and furnace efficiency throughout the long operating period. This depends on the cleanliness of the heating surfaces.

7. The lower the quality of coal, the greater are the power requirements for pulverizers and certain other auxiliary equipment.

A well-operated plant can evaluate all these factors in dollars and cents, thereby determining the true over-all cost of a given coal. Just as important, but somewhat less tangible, is the price tag to be placed on the value of a reliable source of supply.

Sulphur

Sulphur has been in short supply among the nations of the free world since the outbreak of the Korean war. It has been allocated at home and abroad, and consumption has been restricted. Because sulphur is one of the most widely used of raw materials—essential to the production of paper, fertilizer, chemicals, gasoline, steel, rubber, explosives, lubricants, insecticides, paints, and hundreds of other items vital to the economy—the shortage has affected industry and agriculture the world over.

The situation has now changed. Although sulphur consumption is still under government limitation, all but a few consumers in the United States are getting all the sulphur they need. In some cases even, allocations to users are larger than their actual requirements. The shortage in this country is virtually over. Reports from foreign countries, which depend on the United States for a large share of their sulphur supply, indicate a decided improvement there as well.

Furthermore, the outlook for the future is extremely encouraging. Very substantial amounts of additional production of sulphur in various forms are in sight. The following tabulation lists nearly 100 projects in the United States and other free world nations to increase the supply. It is estimated that these projects by the end of 1955 will add an additional 4,000,000 long tons of sulphur in various forms to the free world's annual productive capacity. They are expected to add approximately 1,500,000 long tons to the annual capacity by the end of this year, 1,350,000 tons more by the end of 1953, 250,000 tons more by the end of 1954, and 900,000 tons more by the end of 1955.

If the projects measure up to present estimates, there will soon be enough sulphur for everybody throughout the free world. This anticipated new production is ample to dispel the threat of a continuing shortage.

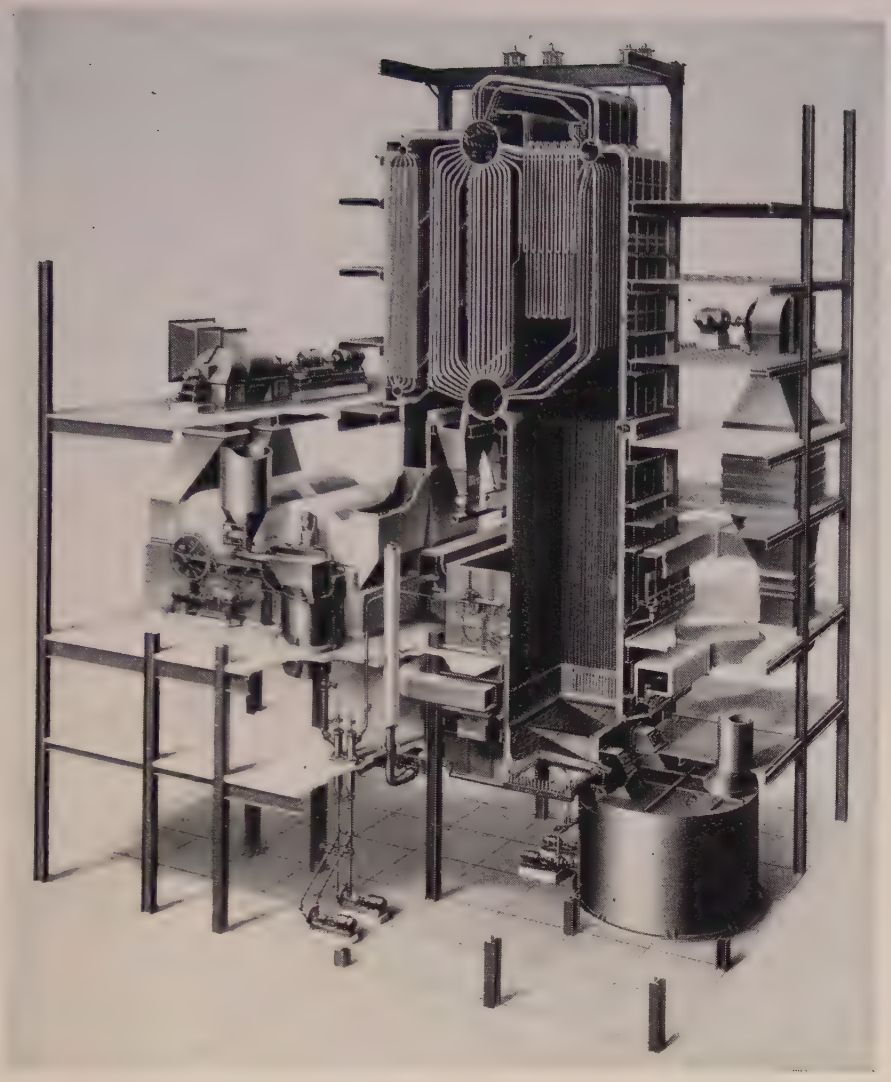
To understand what has happened, it is important to bear in mind that sulphur—the chemical element S—occurs in different forms and is obtained from many sources.

One of the forms of sulphur is brimstone which is free sulphur not combined with any other element. The chief source of brimstone is the Gulf Coast salt domes which are mined by the Frasch "hot water" process. There are, however, other sources. Brimstone is mined from native deposits other than salt domes. It is extracted from sour natural gas, petroleum refinery gases, and smelter gases. It is recovered also from pyrites which are sulphides of iron and other metals.

Sulphur reaches the market, too, in other forms. These include the sulphur content of pyrites, and the sulphuric acid made directly from refinery gases, smelter gases, and sulphate minerals, such as anhydrite. Sulphuric acid, which accounts for four fifths of all sulphur consumption, may be produced from any of these forms of S.

Before World War II, the nations that now make up the free world got most of their sulphur not from American brimstone, our principal form, but from other sources, primarily pyrites. After the war, foreign acid makers in rebuilding and expanding turned from their traditional sulphur sources to American brimstone. Acid plants using brimstone cost less in time and money to build and are more economical to operate. But more importantly, American brimstone is the cheapest and purest of the various forms of S.

During this time when the rest of the free world was becoming more dependent on American brimstone, domestic sulphur needs were growing enormously. The increase in



They keep coming back for more

The highest expression of satisfaction that can be accorded an installation of industrial equipment — or almost anything else for that matter — is that it be selected again and again by the same discerning purchasers.

Measured by that standard alone, the C-E Recovery Unit has an enviable record. Consider the list of pulp and paper companies at the right — a veritable "Who's Who" in the field — that have ordered and reordered the C-E Recovery Unit.

Four of these companies have ordered this equipment on four separate occasions. For example — one company ordered first in 1937, then in 1940, again in 1944 and again in 1950.

Three of the listed companies have ordered C-E Recovery Units three times. The rest have ordered twice.

Only superior performance could account for this record. Such performance explains why users of C-E Recovery Units "keep coming back for more".

Companies that have re-ordered C-E Recovery Units one or more times since 1937.

Brown Corporation
Champion Paper & Fibre Co., The
Chesapeake Corporation
Dryden Paper Company, Ltd.
Enso-Gutzeit Osakeyhito
Gaylord Container Corporation
Longview Fibre Company
MacMillan Export Co., Ltd.
National Container Corporation
North Carolina Pulp Company
Potlatch Forests, Inc.
St. Joe Paper Company
St. Regis Paper Company
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PRODUCTS FOR THE PAPER INDUSTRY INCLUDE RECOVERY UNITS, STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; ALSO PRESSURE VESSELS

Estimated New "Free World" Sulphur Production—1952–55[a]

Long Tons of Sulphur

Company	Location	New capacity to be added during year of 1952	1953	1954	1955	Total new capacity by end 1955
BRIMSTONE						
From Frasch Process						
Freeport Sulphur Co.	Bay Ste. Elaine, La.	100,000	.....	.....	.....	100,000
Freeport Sulphur Co.	Garden Island Bay, La.	.....	500,000	.....	.....	500,000
Freeport Sulphur Co.	Nash Dome, Tex.	.....	.....	70,000	.....	70,000
Texas Gulf Sulphur Co.	Moss Bluff, Tex.	300,000	.....	.....	.....	300,000
Texas Gulf Sulphur Co.	Spindletop, Tex.	400,000	.....	.....	.....	400,000
Mexican Gulf Sulphur Co.	Tehuantepec, Mexico	.....	200,000	.....	.....	200,000
Total Frasch process		800,000	700,000	70,000	.....	1,570,000
From Other Native Deposits						
Sominar, S. A.	El Sosenado, Argentina	.....	10,000	.....	.....	10,000
Industries Purace, S. A.	Popayan, Columbia	12,000	.....	.....	.....	12,000
Chemical Plants Corp.	Tixan, Ecuador	10,000	15,000	.....	.....	25,000
Sicilian Mine Operators	Italy	.....	50,000	.....	50,000	100,000
Japanese Mine Operators	Japan	45,000	55,000	.....	.....	100,000
Guaxcama Mine	Cerritos, S. L. P., Mexico	6,000	.....	.....	.....	6,000
Eti Bank (Government)	Keciberlu, Turkey	.....	7,000	.....	.....	7,000
Anaconda Copper Co.	Inyo County, Calif.	.....	40,000	.....	.....	40,000
Black Rock Desert Minerals Co.	Winnemucca, Nev.	.....	3,000	.....	.....	3,000
Chemical Corp. of America	Sulphurdale, Utah	10,000	.....	.....	.....	10,000
Continental Sulphur & Phos. Co.	Cody, Wyo.	.....	.....	10,000	.....	10,000
Wyoming Gulf Sulphur Co.	Cody, Wyo.	8,000	.....	.....	.....	8,000
Total other native		91,000	180,000	10,000	50,000	331,000
From Sour Natural Gas						
Royalite Oil Co.	Turner Valley, Alta., Canada	10,000	.....	.....	.....	10,000
Shell Oil Co.	Jumping Pound, Alta., Canada	10,000	.....	.....	.....	10,000
Petroleos Mexicanos	Poza Rica, Mexico	10,000	.....	.....	.....	10,000
General Petroleum Corp.	Worland, Wyo.	.....	.....	.....	35,000	35,000
Gulf Oil Co.	Waddell, Tex.	7,000	.....	.....	.....	7,000
Imperial Sulphur & Acid Co.	Farmington, N. M.	.....	21,000	.....	.....	21,000
Mathieson Chemical Co.	Stamps, Ark.	21,000	.....	.....	.....	21,000
Odessa-Sid Richardson	Odessa, Tex.	7,000	.....	.....	.....	7,000
Phillips Chemical Co.	Crane, Tex.	17,500	.....	.....	.....	17,500
Phillips Chemical Co.	Goldsmith, Tex.	44,000	.....	.....	.....	44,000
Phillips Chemical Co.	Eunice, N. M.	35,000	.....	.....	.....	35,000
Sid Richardson Carbon Co.	Keystone, Tex.	8,700	.....	.....	.....	8,700
Seaboard Oil Co.	Silvertip, Wyo.	28,000	.....	.....	.....	28,000
Stanolind Oil & Gas Co.	Slaughter, Tex.	14,000	.....	.....	.....	14,000
Stanolind Oil & Gas Co.	North Cowden, Tex.	7,000	.....	.....	.....	7,000
Warren Petroleum Corp.	Monument, N. M.	.....	5,200	.....	.....	5,200
Total sour natural gas		219,200	26,200	.....	35,000	280,400
From Refinery Gases						
Yacimientos Petrolifeios Fiscales	Buenos Aires, Argentina	.....	.....	10,000	.....	10,000
Petroleos Mexicanos	Atzcapotzalco, Mexico	.....	10,000	.....	.....	10,000
Swedish Shale Oil Co.	Kvarntorp, Sweden	14,000	.....	.....	.....	14,000
Esso Petroleum Co., Ltd.	Fawley, England	.....	12,000	.....	.....	12,000
Shell Oil Co., Ltd.	Shellhaven, England	.....	8,000	.....	.....	8,000
Shell Oil Co., Ltd.	Stanlow, England	10,000	.....	.....	.....	10,000
Trinidad Leaseholds, Ltd.	Trinidad	2,000	.....	4,000	.....	6,000
Atlantic Refining Co.	Atreko, Tex.	.....	5,300	.....	.....	5,300
Cities Service Refining Corp.	Lake Charles, La.	4,200	.....	.....	.....	4,200
Consolidated Chem. Ind., Inc.	Baton Rouge, La.	14,000	.....	.....	.....	14,000
Davison Chemical Co.	Baltimore, Md.	.....	8,500	.....	.....	8,500
Davison Chemical Co.	Linden, N. J.	.....	21,000	.....	.....	21,000
Gulf Refining Co.	Port Arthur, Tex.	21,000	.....	.....	.....	21,000
Hancock Chemical Co.	Los Angeles, Calif.	17,500	.....	.....	.....	17,500
Shell Chemical Co.	Houston, Tex.	17,500	.....	.....	.....	17,500
Sinclair Refining Co.	Marcus Hook, Pa.	7,000	.....	.....	.....	7,000
Standard Oil Co. (Ind.)	Whiting, Ind.	19,200	.....	.....	.....	19,200
The Texas Co.	Port Arthur, Tex.	8,700	.....	.....	.....	8,700
Union Oil Co.	Wilmington, Calif.	22,700	.....	.....	.....	22,700
Total refinery gases		157,800	64,800	14,000	.....	236,600
From Pyrites						
Noranda Mines, Ltd.	Welland, Ont., Canada	.....	20,000	.....	.....	20,000
From Smelter Gases						
Cia. Real de Austuriana	Bilbao, Spain	.....	10,000	.....	.....	10,000
Total Brimstone		1,268,000	1,001,000	94,000	85,000	2,448,000
OTHER SULPHUR						
In Pyrites						
Four-Company Combine	Nairne, Australia			30,000	.....	30,000
Mt. Lyell Mining & Rwy. Co.	Tasmania, Australia				12,000	12,000
S. A. Reunidas F. Materazzo	São Paulo, Brazil			6,000	.....	6,000
Columbia Cellulose Co.	Prince Rupert, B. C., Canada	14,000		.....	.....	14,000
Consolidated Mining & Smelting Co.	Kimberly, B. C., Canada			30,000	.....	30,000
Consolidated Paper Corp.	Grand-Mere, Que., Canada	4,000	.....	.....	.....	4,000
Noranda Mines, Ltd.	Noranda, Que., Canada	.....	35,000	.....	.....	35,000
Normetal Mining Corp.	Dupuy, Que., Canada	6,000	.....	.....	.....	6,000
Electro Kjemisk	Skovoras, Norway	75,000	.....	.....	.....	75,000

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Wyandotte
CHEMICALS

Estimated New "Free World" Sulphur Production—1952–55[a] (*Continued*)
Long Tons of Sulphur

Company	Location	New capacity to be added during year of— 1952	1953	1954	1955	Total new capacity by end 1955
National Power Corp.	Rapee Island, Philippines	.....	.....	.....	10,000	10,000
Rio Tinto and Tharsis	Huelva Province, Spain	.....	.....	.....	735,000	735,000
Board of Trade Project	Rudtjeback, Vb., Sweden	.....	50,000	.....	50,000	100,000
West Rand Consol. Mines, Ltd.	Umbogintwini, South Africa	.....	18,000	.....	.....	18,000
Bethlehem Steel Co.	Berks County, Pa.	.....	28,000	.....	.....	28,000
Brown Co.-Vermont Copper Co.	Berlin, N. H.	6,000	.....	.....	.....	6,000
Total pyrites		105,000	131,000	66,000	807,000	1,109,000
In Refinery Gases						
Consolidated Chemical Industries	Baytown, Tex.	.....	17,500	.....	.....	17,500
Stauffer Chemical Co.	Compton, Calif.	.....	8,700	.....	.....	8,700
Tide Water-Monsanto Chemical	Avon, Calif.	12,000	.....	.....	.....	12,000
Total refinery gases		12,000	26,200	.....	.....	38,200
In Smelter Gases						
Bleiberg Mining Union, Ltd.	Carynthia, Austria	5,000	.....	.....	.....	5,000
Union Miniere-Metalkat	The Katanga, Belgian Congo	.....	.....	5,000	.....	5,000
Aluminum Co. of Canada, Ltd.	Arvida, Que., Canada	15,000	.....	.....	.....	15,000
Consolidated Industries, Ltd.	Copper Cliff, Ont., Canada	45,000	.....	.....	.....	45,000
Sherritt-Gordon Mines, Ltd.	Ft. Saskatchewan, Alta., Canada	.....	.....	15,000	.....	15,000
American Smelting & Refining Co.	San Luis Potosi, Mexico	3,000	.....	.....	.....	3,000
American Smelting & Refining Co.	Amarillo, Tex.	.....	12,500	.....	.....	12,500
American Smelting & Refining Co.	Tacoma, Wash.	10,000	.....	.....	.....	10,000
American Zinc Co. of Illinois	Fairmount City, Ill.	3,000	.....	.....	.....	3,000
American Zinc Co. of Illinois	Dumas, Tex.	.....	.....	22,000	.....	22,000
Bunker Hill & Sullivan Min. Co.	Kellogg, Idaho	30,000	.....	.....	.....	30,000
Garfield Chemical & Mfg. Co.	Garfield, Utah	.....	25,000	.....	.....	25,000
Total smelter gases		111,000	37,500	42,000	.....	190,500
In Sulphate Minerals						
Austrian Nitrogen Works	Linz, Austria	.....	5,000	20,000	.....	25,000
I. G. Farbenindustrie	Wulfen, West Germany	.....	.....	.....	30,000	30,000
Government Fertilizer Works	Sindri, India	20,000	50,000	.....	.....	70,000
Government Fertilizer Project	Mari Indus, Pakistan	.....	.....	12,000	.....	12,000
Imperial Chem. Ind., Ltd.	Billingham, England	.....	25,000	.....	.....	25,000
Solway Chemicals Ltd.	Whitehaven, England	.....	.....	23,000	.....	23,000
United Sulphuric Acid Corp.	Merseyside, England	.....	70,000	.....	.....	70,000
Total Sulphate Minerals		20,000	150,000	55,000	30,000	255,000
Total other sulphur		248,000	344,700	163,000	837,000	1,592,700
Total brimstone		1,268,000	1,001,000	94,000	85,000	2,448,000
"Free world" grand total		1,516,000	1,345,700	257,000	922,000	4,040,700

SUMMARY

	Estimated total 1951 production	Estimated new capacity 1952–55 — Brimstone	Other sulphur	Total
United States	6,180,000	1,858,000	174,700	2,032,700
Canada	329,000	40,000	164,000	204,000
Mexico	52,000	226,000	3,000	229,000
Total North America	6,561,000	2,124,000	341,700	2,465,700
Europe	3,730,000	154,000	1,088,000	1,242,000
Asia	1,200,000	107,000	92,000	199,000
South America	56,000	63,000	6,000	69,000
Oceania	105,000	.....	42,000	42,000
Africa	44,000	.....	23,000	23,000
Total other areas	5,135,000	324,000	1,251,000	1,575,000
"Free world" grand total	11,696,000	2,448,000	1,592,700	4,040,700

[a] Estimates based on published information and trade sources. July 1952.

sulphur use was much greater than the increase in the use of minerals in general. To meet the huge demand, the American brimstone industry increased its output by 1950 to about two and a half times the average for the prewar years 1935–39. This gain was much greater than the gain in other industrial production.

After the outbreak of the Korean war in mid-1950, the demand for sulphur took a further surge upward. In order to meet the huge domestic and foreign demands made upon American producers in the last half of 1950, withdrawals of sulphur were made from stockpiles, and it was clear that the full demand could no longer be met.

At the beginning of 1951, in accordance with our national policy of helping our allies, our government instituted an export allocation system. It earmarked sulphur for export and directed producers to ship specified tonnages overseas. While the system resulted in a small reduction in exports, it had the effect of maintaining shipments overseas at a very high rate compared to those of the past decade.

Sulphur production in the United States was sufficient to meet all domestic needs but not domestic needs *plus* export allocations. In view of this situation it was necessary to limit sales to domestic consumers. The allocation of sulphur at home was undertaken initially by the producers themselves who established individual systems.

In testimony before a House committee in February of 1951, The Freeport Sulphur Co. urged that the government, in the exercise of the powers which had been given to it by Congress, issue an order to insure that the sulphur that was being produced would "be used in the national interest." Freeport also called attention to the importance of developing new sources of supply and of conserving and reusing sulphur wherever feasible. It predicted that a great deal would be done in these directions.

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a...speed up your paper machines

b...install additional or larger machines

c...operate with greater tonnages of slower stock

d...reduce stock losses

To carry out any one of these plans will involve handling greater volumes of white water which may be beyond the capacity of the largest single drum type Saveall. If floor space is no problem, you can make your choice between the Oliver Drum Type Saveall and the American Disc-Type Saveall. BUT, if extra floor space is either non-existent or set aside for other purposes, look into the merits of the American Saveall.

The largest American can provide a filtering area approximately three times that of the largest Oliver drum type unit yet requires only approximately the same floor area. It has exceptionally high dewatering efficiency. It will give you the highest capacity for a limited floor area. It provides greatest flexibility in filtering area.

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In the middle of 1951, the government limited domestic sulphur consumption to 100% of the amount used in 1950. However, in order to supply consumption in 1950, the last half of which reflected the effect of the Korean war, it had been necessary to make withdrawals from stockpiles. Consequently current production, after export allocations were filled, was insufficient to maintain the level of consumption permitted under the government order. The producers therefore had to continue their individual allocation systems.

In October, Freeport, in a booklet on the sulphur situation, warned that, while the long-range outlook was favorable, the shortage would get worse in the coming months before it got better. It pointed out that the supply of sulphur could not meet the total demand and that stockpiles were at a minimum for national security and must not be reduced. It urged that the government, having assumed complete control of sulphur distribution, determine which uses were essential to the defense effort and direct shipments accordingly.

At the beginning of 1952 the government restricted further the use of sulphur, limiting consumption to a basis of 90% of the amount used in 1950, and adopted the policy of maintaining existing stockpiles. The new order, it was said, "makes it possible . . . to support military and defense requirements for sulphur through the issuance of directives to sulphur suppliers." Sufficient sulphur has been available to carry out this program.

Actually, sulphur is one of the most plentiful of the earth's elements. The total reserves in various forms are enormous, but the cost of production of many of the sources is higher than that of brimstone. Normally, when a shortage occurs, the price increases. The higher price brings out more production, and supply and demand are again in balance. Although in this situation government price controls prevented any increase in the price of U. S. sulphur, the shortage itself is a stimulant to greater production. Efforts were undertaken on many fronts.

The long-range exploration program of the American brimstone industry, which for many years has risked large sums of money on exploration and development, brought encouraging results. Announcements were made of new discoveries and of plans to develop new mines. In addition, other projects were formulated to obtain sulphur in some form from refinery gases, smelter gases, sour natural gas, surface deposits, and pyrites.

Simultaneously progress was being made in a direction that led to the same result as increased production—the conservation of sulphur. One type of conservation is the recovery and reuse of spent sulphuric acid and of waste materials which can be converted into sulphuric acid. This type includes such activities as the reclaiming of spent pickle liquors at steel mills, salvage of sulphur values from spin bath solutions in rayon plants, and recovery of the acid content from oil refinery sludge. A second type of conservation lies in ways to use less sulphur to make each unit of end product. For example, unit consumption of sulphur by the sulphite pulp industry has been reduced by approximately 10% since 1950.

In other free world countries also, many efforts to increase the sulphur supply were undertaken. Projects of one kind or another were reported in Canada, Mexico, England, Spain, Italy, Japan, and a number of other nations. These efforts were of definite significance to the United States because foreign consumers have been looking to us for so much of their sulphur. Any increase in their own supplies would lessen the drain on our resources.

The prospect of this new production made the long-term outlook much more favorable. Freeport was able to report in February of 1952 that the "end of the tunnel" was in sight. While sulphur was still in short supply and while much of the new production was still a considerable way off, the future was very much brighter.

Despite the high level of demand during the shortage, a large part of the needs of our allies for sulphur were supplied, and all of the requirements of our own essential defense industries and a high percentage of other domestic needs were met. At the same time stockpiles were kept from falling below the minimum for national security. The sulphur industry is proud of this achievement which was made with the active cooperation of sulphur consumers and of the government agencies concerned.

At the present time, as a result of increased supplies, conservation in use and some easing of demand, sulphur supply and demand in the United States are practically in balance. While sulphur is still under government restriction, nearly all consumers are getting all the sulphur they want.

The outlook for future sulphur supplies is highly encouraging. New production in the offing has reached a very impressive total. The following tabulation, which has been compiled from published information and trade sources, provides a list of new projects to increase the supply of sulphur in various forms, as well as estimates of the new production. The tabulation may be summarized as follows (figures are in long tons of sulphur or sulphur equivalent):

	Estimated 1951 production	*Estimated new capacity 1952–55*
United States	6,180,000	2,032,700
Other countries	5,516,000	2,008,000
Total	11,696,000	4,040,700

The Defense Production Administration has set a goal for annual production in the United States by 1955 of 8,400,000 long tons of sulphur in all forms. It has estimated that domestic requirements would increase to 43% above 1950, or to about 7,000,000 long tons, which would leave about 1,400,000 long tons for export. The D.P.A. forecast is predicated on a rate of growth much greater than that on which the 1975 estimate of the President's Materials Policy Commission was predicated. But even if demand should increase by 1955 to the level estimated by D.P.A. as representing the requirements of U. S. industry, the new projects in the United States will provide enough additional sulphur to meet this level, and at the same time the foreign projects listed will reduce the export requirements which would otherwise exist.

The outlook for the future thus is excellent. Assuming the new projects measure up to present estimates, there should be ample supplies of sulphur for consumers the world over.

Swedish Pulp and Paper Exports

The following brief statement relative to Sweden's foreign trade in pulp and paper appeared in the July 18 issue of the "International Financial News Summary" issued by the International Monetary Fund.

"During June it became clear that the exceptional boom in the Swedish Forest industries had definitely come to an end, according to an article in 'Affarsvarlden.' The high prices on wood pulp and paper have stimulated plans for increasing production in the main importing countries. Another result of the boom is that Swedish pulpwood prices, and even wages, were increased. It is regrettable, the article states, that the exceptionally favorable export boom did not result in as large an improvement in Swedish gold and foreign exchange reserves as could have been expected.

"According to Swedish foreign trade statistics, the average export price for wood pulp was some SKr 1600 kronor (SKr 5.18 = U. S. $1) per ton in the Fall of 1951. Of this price, about SKr 475 was paid in export duties. The price level in

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the third quarter of this year will probably be about SKr 900 per ton, but 'Affarsvarlden' expects that the average price for 1952 will be about SKr 1000 per ton, or some SKr 400 less than the average price for last year. In addition to a reduction in price, there might also be a decrease in quantity. For other forest product exports also, a decline in both price and quantity is expected. It seems possible, the article concludes, that the 1952 export value of forest products will be about SKr 1–2 billion (or 20–40%) less than in 1951. Total exports of all goods from Sweden amounted to SKr 9 billion in 1951."

Circular Saw Manufacturers

The two most popular saws presently in use in the Southern States are manufactured by Kut-Kwick and Tidewater. The companies making and selling saws are as follows:

Cummings Machine Works, 9–11 Melcer St., Boston 10, Mass.
Henry Dieston & Sons, Inc., Tacony, Philadelphia 35, Pa.
Jacobs Wind Electric Co., Inc., 2111 Washington Ave., N. Minneapolis 1, Minn.
Jaques Power Saw Co., Box 695, Denison, Tex.
Kut-Kwick Tools, Brunswick, Ga.
Mall Tool Co., 7740 S. Chicago Ave., Chicago 19, Ill.
Mathis Welding & Machine Co., 730 N. Hernando St., Lake City, Fla.
McLean Iron Works, Box 550, Palatka, Fla.
Ottawa Manufacturing Co., Ottawa, Kan.
Schmidt Machine & Tool Sales, 403 Stanton St., Bay City, Mich.
Tidewater Equipment Co., Box 14, Brunswick, Ga.
Tool Engineering Service, 505 W. 22nd St., Birmingham, Ala.
Turner Manufacturing Co., Statesville, N. C.
Webb Tree Saw Co., Demopolis, Ala.

Paper Industry in Mexico

The installation of a new factory for newsprint production in Mexico will be completed before the end of 1952. A plan to encourage the production of paper was approved by the Mexican government on July 5. Although 22 small paper factories are in operation at present, production has been limited; between 1946 and 1951, it increased by only 50,000 tons, from 70,000 tons to 120,000 tons. With the facilities offered by the government, manufacturers hope to use Mexican raw materials for paper production to supply all domestic needs.

Crossett

The Crossett Lumber Co. and the Southern Lumber Co. will cooperate with the Southern Forest Experiment Station, New Orleans, in financing fundamental research in forest soils and genetics.

By agreements recently completed, the two companies will contribute during the next five years a total of $45,000 toward financing the new projects. Other lumber and pulp companies, Mitchell said, have indicated an interest in this work and may also participate when the research gets under way.

The Southern Station, a branch of the U. S. Forest Service, will provide supervisory personnel, technical specialists, do the planning, and carry out the field and laboratory studies. Most of the work will be centered at the Crossett (Ark.) Branch of the Southern Station, under the general supervision of R. R. Reynolds.

The agreement with the Crossett Lumber Co., Crossett, Ark., is for experiments in forest genetics. P. F. Watzek, president of the company, has stated that the objective is to "develop strains of fast-growing, high-quality, pest-resistant, and otherwise superior trees adapted to forest lands in Arkansas and other southern States."

The second agreement, with the Southern Lumber Co. of Warren, Ark., provides for basic research in forest soils. According to W. R. Warner, manager of the company, this study will be concerned with determining the physical, biological, and chemical properties of major forest soils in southern Arkansas and adjacent regions, the effects on soils of prescribed burning and various methods of forest management, and other factors influencing the productivity of forest soils.

Earl Stone, Professor of Forest Soils at Cornell University, has been engaged by the Southern Station as a consultant to help plan the soils study. He expects to start this assignment about July 1. R. E. Schoenike, who will complete his graduate studies at the University of Minnesota in September, will be assigned to the genetics project.

Lumber and pulp companies in the South have long cooperated with the U. S. Forest Service in conducting applied research in forestry. What is unique about the new cooperative agreements is that they are pioneering ventures by southern forest industries in sponsoring substantial basic research in the long-neglected subjects of forest soils and genetics. They offer further evidence of the farsighted policy of the majority of large industrial owners in the South and the rapid progress they are making toward maximum yields and sustained production from their timberlands.

Certificates of Necessity

The Defense Production Administration reports that ten certificates were issued to the pulp and paper industry between April 15 and June 20, 1952. These amounted to $79,413,00 and were 2.7% of the total amount represented by the certificates.

The cumulative figures as of June 20, 1952, were 127 certificates issued, amounting to $745,892,000 or 3.5% of the total.

Certificates pending as of June 20 were 72, amounting to $85,858,000 or 1.4% of the total.

Progress toward completion of facilities issued through March 31,1952 (including construction, machinery, and equipment) covers 38 certificates for pulp mills, amounting to $306,762,000. The value in place on March 31, 1952, was $129,928,000 or 42% of the total and on June 30, 1952, $148,412,000 or 48% of the total.

It also covered 51 certificates for paper and board mills, amounting in value to $304,540,000. The value in place on March 31 was $105,028,000 or 34% of the total. On June 30 it was $128,958,000 or 42% of the total.

Wastepaper

For the first five months of this year, the national collection of wastepaper amounted to 3,176,547 tons, and consumption 3,197,984 tons. It is interesting to note that the mills of the nation purchased 5.2% more wastepaper during the first five months of this year than during the first five months of 1950, when mill receipts amounted to 3,021,257 tons. During the first five months of last year, the mills bought 4,308,469 tons of wastepaper.

Only 4% less wastepaper was consumed in the United States during the first five months of this year than during the last five months of 1951, according to Government figures released last week. Paperboard mill consumption of wastepaper was only 2.8% below that of the previous 5-month period, paper mill consumption down 8.4% and building materials mills consumption down 6.7%.

Compared with that peak period, the first five months of 1951, however, the total drop in the consumption of wastepaper was 23%. The paperboard mills suffered the greatest drop during the first five months of this year from the first five months of 1951, amounting to 25.6%. Paper mill consumption dropped 12.3%, building materials mills 19.8%, and wet machine board mills 12.9%.

During the first five months of this year the paperboard mills consumed 75% of the total wastepaper consumption, the paper mills 16%, the building materials mills 8%, and the wet machine board mills 1%. In the first five months of last year, the paperboard mills consumed 77% of the total wastepaper consumption, the paper mills 14%, the building materials mills 8%, and the wet machine board mills 1%.

Wastepaper consumption for the three periods follows:

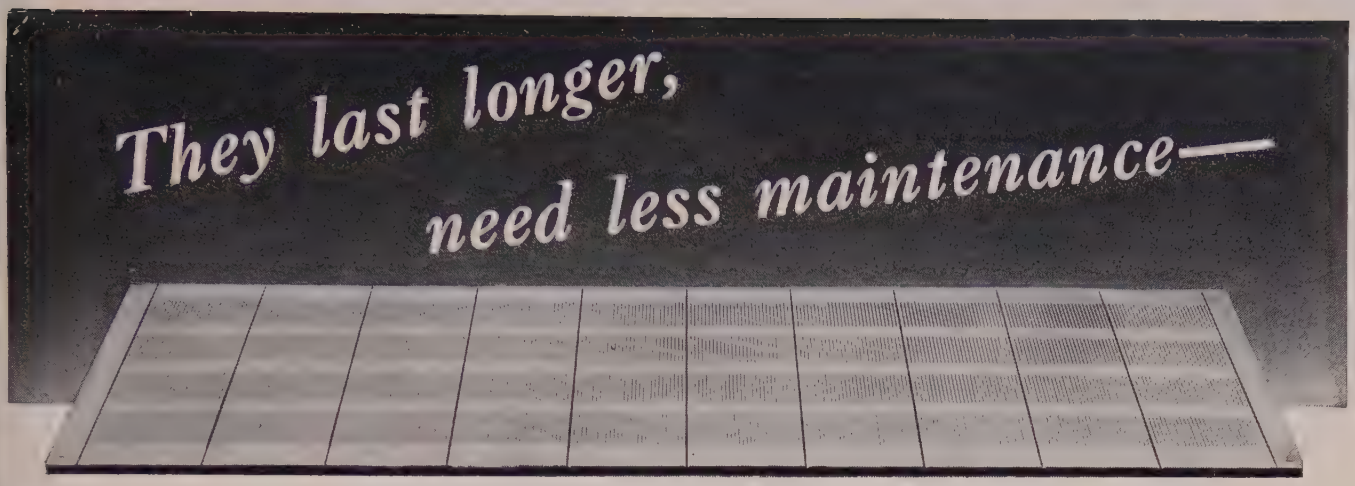


Photo courtesy Magnus Metal Corporation, Fitchburg, Mass.

Can Inconel Screen Plates Reduce Your Replacement Costs?

Nearly nine years ago, a Canadian mill decided to see if they could get longer service life from screen plates. Up to that time, the best screen plates tried had failed through corrosion or fatigue, after only about a year of service.

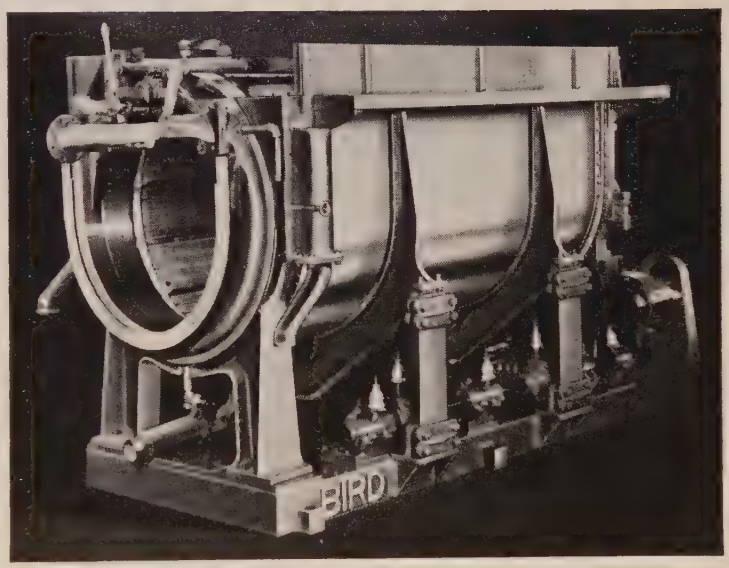
Then, in 1943, they tried screen plates of Inconel®. Today – *nearly nine years later* – these Inconel plates look as good as new.

This long plate life can be credited to two outstanding characteristics of Inconel – exceptional resistance to fatigue and corrosion by mill stocks.

Inconel is virtually unaffected by chemicals used in the pulp and paper mill. And – because Inconel does not readily work-harden – it is capable of withstanding severe vibration and shock which often cause other metals to fail through "fatigue."

For further information about Inconel screen plates, write directly to Magnus Metal Corporation, Fitchburg, Mass.

Right now the INCO Nickel Alloys are on extended delivery because so much is needed for defense. So, it's wise to anticipate your needs and place your orders (with necessary N.P.A. ratings) with your INCO distributor well in advance.



Inconel screen plates in position on a Bird machine. Photo courtesy Bird Machine Co., South Walpole, Mass.

THE INTERNATIONAL NICKEL COMPANY, INC.

67 Wall Street, New York 5, N. Y.

EMBLEM OF SERVICE

NICKEL INCO ALLOYS

MONEL® • "R"® MONEL • "K"® MONEL • "KR"® MONEL • "S"® MONEL
NICKEL • LOW CARBON NICKEL • DURANICKEL®
INCONEL® • INCONEL "X"® • INCOLOY® • NIMONICS

	First 5 months, 1952	Last 5 months, 1951	First 5 months, 1951
By paper mills	504,544	550,870	575,526
By paperboard mills	2,385,389	2,455,882	3,207,767
By wet machine board mills	33,648	29,968	38,655
By building materials mills	274,255	294,148	342,138
Totals	3,197,836	3,330,868	4,164,086

August began with Eastern board mill inventories of wastepaper about 20% below what they were on this date a year ago, 17% higher than on Aug. 1, 1950, and 2.5% below inventories on Aug. 1, 1949. By grades, mill inventories of wastepaper for the last five years on August 1, were divided in the following ratios in per cent:

Grade	1948	1949	1950	1951	1952
Mixed	24	26	21	18	20
News	31	31	29	36	28
Container	27	23	24	26	27
High grades	18	20	26	20	25

Quality will continue to be uppermost in wastepaper purchases by mills during the coming months, and this includes not only the paper board and paper mills, but the roofing mills as well.

Pollution Control

Total outlay of the Sulphite Pulp Manufacturers' Research League for research to reduce sulphite pollution of Wisconsin streams passed $1,000,000 during June, A. J. Wiley, technical director, announced in his semiannual report to the League's technical committee. This figure is up more than $70,000 since the end of 1951.

Since its founding in 1939 as a cooperative group to do scientific work on ways to treat or utilize spent sulphite liquor and thus reduce pollution, the League has carried on 34 major research projects. Of these projects, 17 were eventually given up as nonproductive and 17 remain active. During this 13-year period, the research staff has prepared 121 technical progress reports for member mills, 71 of these reports cover projects still active and 50 dealt with projects since abandoned.

The largest single group of active research projects on the League's current program consists of seven studies now going forward in the field of applied chemistry. The largest group of reports is 40, covering yeast and other fermentation processes which have been under study and test since 1941. Evaporation-and-burning, which became a possibility only after Swedish development of nonscaling evaporator equipment late in World War II, has been the subject of four reports since 1950. The rest of the research reports are on various aspects of sulphite liquor technology, including chemical processes, binders and paving uses, and basic research.

Pulp and paper mills on the Fox River have spent in the past three years or agreed to spend in the near future between $9,500,000 and $10,000,000 to reduce stream pollution, mill representatives reported to the State Commission on Water Pollution at a meeting in Green Bay last week.

Four mills have really major pollution-control programs in various stages of completion. Each of these projects is costing in excess of $2,000,000. Eight other mills are spending smaller sums to meet less acute pollution problems. Because most of these installations have not yet been completed, exact cost figures cannot now be determined, but the preliminary totals add up to just over $9,800,000.

Drainage Basins

The Federal Security Agency, Washington, D. C., has issued No. 16 in its Water Pollution Series "Southwest-Lower Mississippi Drainage Basins." This report covers Arkansas, Colorado, Kansas, Kentucky, Louisiana, Mississippi, Missouri, New Mexico, Alabama, Tennessee, and Texas.

Largest Greaseproof Paper Machine

In 1929 a paper machine was procured by G. A. Serlachius Oy for their mills at Mantta. The machine was the largest of its kind in the world. Over the course of years still larger paper machines have been constructed, and now the Serlachius concern takes the lead again. Recently, to be exact on May 27, a greaseproof paper machine was started which is the largest in the world today. To hold the new machine the premises of the paper mill at Mantta have been enlarged in the last few years by approximately 70,000 cu. m. The new machine is over 100 meters in length and its wire width is 5.5 m. The machine was made by J. M. Voith at Heidenheim, Western Germany, and its delivery time was two years. About 150 railway trucks were needed to carry the machine which weighs 1100 tons. Its gross output is over 40 tons per day. Its net working width is 180 in. Owing to the reconstruction now effected the production of the paper mill increases by about 40%. Simultaneously with the extension to the mill special attention has also been paid to the improvement of social conditions and the rationalization of work.

Kimberly-Clark

Thirty-six representatives of fine paper distributors from coast to coast attended a printing paper school conducted by Kimberly-Clark Corp. at Neenah, Wis., July 16–18. First of its kind to be held by Kimberly-Clark, the three-day school for sales staff members and officers of merchant firms centered around the features of Kimberly-Clark coated printing papers, markets, competition, and the services provided by the manufacturer.

A highlight of the program was an offset printing demonstration by Charles Shapiro, manager of the educational department of the Lithographic Technical Foundation. Demonstrating with a press, he showed that only ink adjustments are necessary to print on Kimberly-Clark coated lithographic paper after printing on uncoated paper. Howard Watrous, also of the Foundation, and David Campbell of American Type Founders assisted Shapiro in the demonstration of an ATF Big Chief press, set up expressly for the school.

Kimberly-Clark's staff faculty for the school numbered 11. The school program included visits to the company's Research and Development Laboratory and two of its mills.

Matches

The kitchen match, with wooden stem and strike-anywhere, is losing out in the battle with modern substitutes—everywhere except in Brooklyn. In Brooklyn, the kitchen match still flares with opalescent beauty. Brooklyn is the nation's greatest consumer of kitchen matches. This is the 125th anniversary of the discovery of the modern match.

The free match is even more American than the hot dog. Last year 508 billion matches were made in the United States. About 13 billion books of 20 matches, or nearly 90% of the total production, were flipped over the counters of America for free—a million and a half books of matches an hour, 24 hours a day, each day of the year.

The first modern match was sold on April 7, 1827, by a pharmacist named John Walker in Stockton-on-Tees, England. Being a medical man, John sold his matches under the name of Sulphurata Hyperoxygeneia Frict. Even so, they caught on.

In 1892 Yankee ingenuity took over the match and a Philadelphia patent lawyer named Joshua Pusey, finding it a long time between clients, snipped out the first book of matches with his office shears and brewed the igniting element on his stove.

It was a go-getter named Henry C. Traute who put over the

NOW! MILL-PROVED FOR PRODUCING LINER BOARD KRAFT!

CHEMI-PULPER®
continuous digester

The mill trials were made in a large kraft mill now using CHEMI-PULPER continuous digesters for producing corrugating board pulp from mixed hardwoods.

Based on a series of trial runs, the operating conditions for the CHEMI-PULPER continuous digester were determined and the operation was placed on a 24-hour basis.

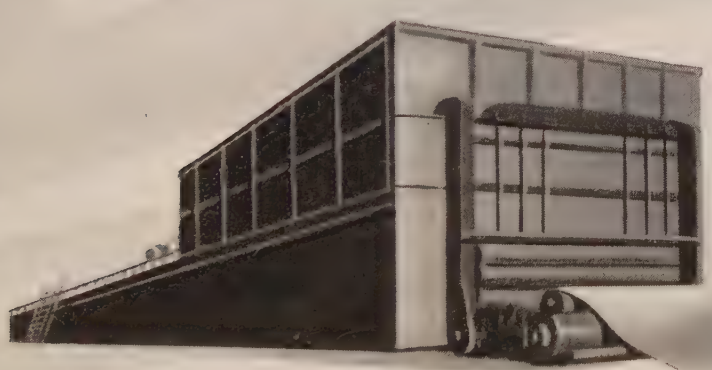
High yield kraft pulp in the 60-62% range was produced from a mixture of spruce and balsam woods. The pulp passed through hot stock refiners—over a vacuum washer—through the board machine disc refiners and onto the liner board machine. The liner board was made from 100% CHEMI-PULPER continuous digester kraft pulp at the usual mill operating speed and tested somewhat higher than the minimum requirements for .016 liner.

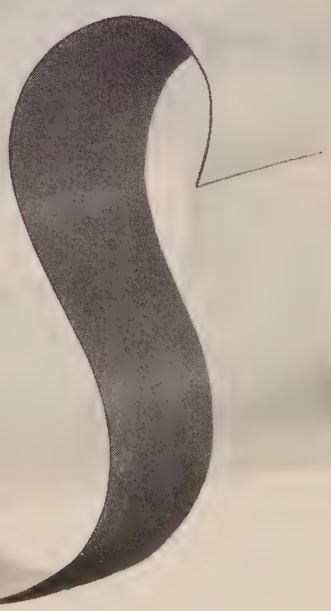
The CHEMI-PULPER continuous digester can produce kraft pulp continuously at a considerable *saving in steam and manpower* requirements, and at a *better uniformity* which is an inherent characteristic of a continuous process as compared to a batch operation.

Again, PANDIA INC. with the CHEMI-PULPER continuous digester is first. As a pioneer and developer of the only mill proven continuous pulping equipment, we believe that this commercial run marks the first time on this continent that kraft pulp has been produced continuously on a 24-hour basis and run out into liner board.

Whatever your need, a PANDIA engineer will gladly confer with you regarding your particular problem.

Bulletin upon request.





Manufactured and Sold in Canada by
THE ALEXANDER FLECK LIMITED, OTTAWA, CANADA.

PANDIA

PANDIA INC.

122 EAST 42nd STREET • NEW YORK 17, N. Y.

idea of printing advertising on the match covers, and made it possible to give them away free. The idea caught on with little coffee shops and big steel companies, and came into flower when Wrigley ordered one billion books of matches to put over Doublemint chewing gum.

The combustion point of matches has been raised from 220 to 350 degrees and higher and the collection of book matches has become a big, if not very inspired hobby. The Truman-Barkley inaugural dinner matches, Jan. 19, 1949, now go for $8.00 a book and the Lindbergh flight match brings $100.

Columbine

A new western Colorado firm, Columbine Pulp and Paper, Inc., has been formed to produce newsprint in Western Colorado. Plans at present call for building a plant between Grand Junction and Glenwood Springs. Directors of the new company include several Colorado newspaper publishers and officials.

Through merger or purchase this company hopes to acquire the holdings of the Columbine Development Corp. which has already conducted considerable research for a proposed newsprint mill in the same area.

U.S.S.R. Timber

The German publication *Ost-Europa* reports the Soviet Union has about 2,500,000,000 acres of wooded land, by far the largest area of trees possessed by any country, according to data released by V. Koldanov, Deputy Minister of Forest Economy.

The total volume of Soviet timber supplies is about 59 billion cubic meters, or more than twice as much as that of the United States, Canada, Sweden, and Finland taken together. This figure is roughly 50% greater than earlier estimates of Soviet timber resources.

It is thought data on Soviet timber reserves and supplies are of particular interest now because of recent Moscow offers to expand timber exports to the West substantially, if existing trade restrictions were lifted.

The German publication quotes about 60% or 1,500,000,000 acres of Soviet timber areas consist of full-grown trees suitable for immediate logging.

Benchmarks

The circulation of English language newspapers in the United States reached a total of 100,297,000 daily in 1951.

With only 6% of the world population the United States consumes 68% of the world production of paper and paperboard.

There were 1,200,000 blueprints used in the construction of the S.S. *United States*.

The per capita consumption of frozen fish in 1933 was 4.2 lb. In 1950 it was 6.3 lb.

Institute of Paper Chemistry

Ground will be broken in the immediate future for construction of the new General Activities Center of The Institute of Paper Chemistry.

The building, which will cost approximately $350,000 completed, will have slightly less than 21,000 sq. ft. of floor space. It will provide space for academic offices and seminar rooms, an accounting office, a secretarial office, a central file office, conference rooms, and the administrative offices of the Institute. In addition, the building will contain a museum, an assembly room seating more than 200 persons, space for duplicating facilities, and a sub-basement for storage purposes.

The general contract for the building has been let to the Hoffman Co., Inc., of Appleton, and it is hoped that the building will be completed by the end of the 1952–53 school year. Occupation of the building will vacate over 16,000 sq. ft. of space in the present buildings. This space, which is constructed for heavy duty service, will be converted into laboratories which are needed to serve the growing educational and research programs of the Institute.

Hudson Pulp and Paper

The successful advertising campaign of the Hudson Pulp and Paper Co. was written up recently in the New York *Herald-Tribune*. The campaign was based on a desire to establish brand consciousness. The procedure used consisted of advertising daily for products such as paper napkins which are purchased everyday. About one million dollars were appropriated for a campaign on a broad scale. The theme of the copy was linen napkin luxury at paper napkin prices. In three years Hudson napkins have become the top brand in Chicago. In New York a survey showed that 72.6% of the napkin buyers bought Hudson. According to the annual report, it sold 16,217 tons in 1951, or about 100,000 cases a month.

Alabama Forests

After more than a century of use Alabama's commercial forests are producing new crops of trees at a rate that is almost one third faster than the national average. While Alabama has only 4% of the country's commercial forest area, the state's forests account for 5.7% of the nation's growth. Alabama passed Texas in June to regain the national leadership in total number of tree farms. The state now has 404 farms of 2,593,950 acres.

Crown Zellerbach

In June Crown Zellerbach Corp. completed its seasonal planting and aerial seeding of 4336 acres of logged-over land in the Columbia River area. Helicopter seeding covered 520 acres on the Cathlamet, Wash., tree farm and 700 acres on the Columbia County, Ore., tree farm. A total of 827,000 seedlings were planted on five of the Company's Oregon tree farms.

During the past year the Crown Zellerbach Foundation was established. The Foundation is intended to provide more efficient administration of contributions by the corporation for scientific, educational, and philanthropic purposes, all of which directly or indirectly benefit the corporation as well as the community generally. Contributions to the Foundation will be made from time to time by the corporation. An initial grant of one million dollars was made in April, 1952, representing a net cost to the corporation after taxes, of $180,000.

The Industrial Products Div., a new operating division was established to coordinate the manufacture and handling new products derived from the nonfibrous portion of wood. The first product developed is called Orzan, a material derived from ammonia-base sulphite liquor. It is used as a dispersing agent, adhesive base, binder, and soil conditioner.

Another derived product developed earlier is coindendrin, a complex compound found in western hemlock. It has been shown to have high value as an antioxidant.

Paper Plates

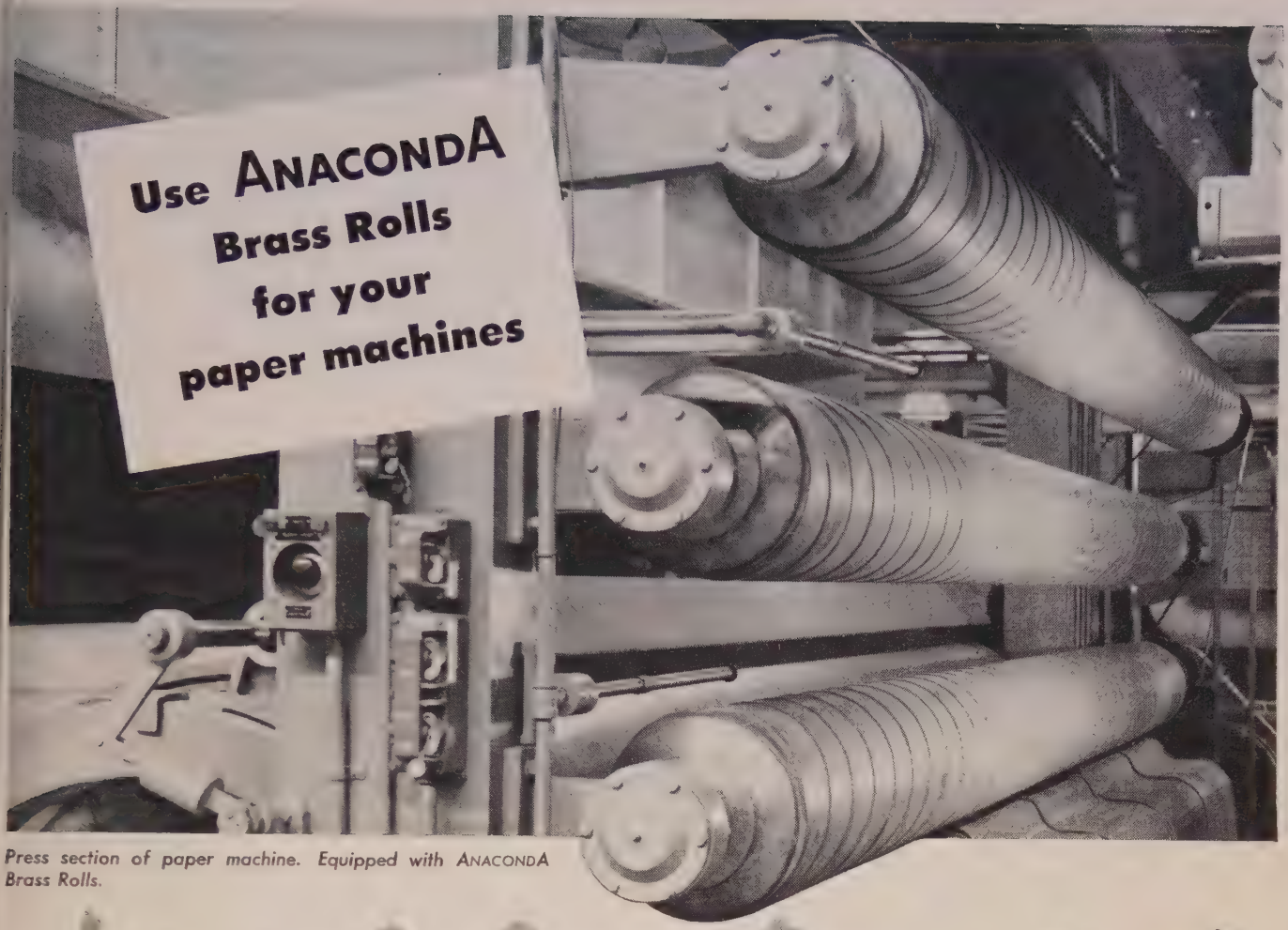
The Paper Plate Assn. advises that 66,432,000 units were sold in June, up 56.8% from June, 1951.

Lowell Textile

John Lewis has been appointed Head of the Department of Paper Engineering at Lowell Textile Institute, Lowell, Mass., succeeding Geoffrey Broughton who has joined the Chemical Engineering staff of Rochester University.

National Container

The following changes in personnel at the Jacksonville and Valdosta mills of National Container Corp. are announced as of August 1:



Press section of paper machine. Equipped with ANACONDA Brass Rolls.

be safe from Corrosion!

BRASS is the economy metal for corrosion resistance —the metal that does the job at lowest cost.

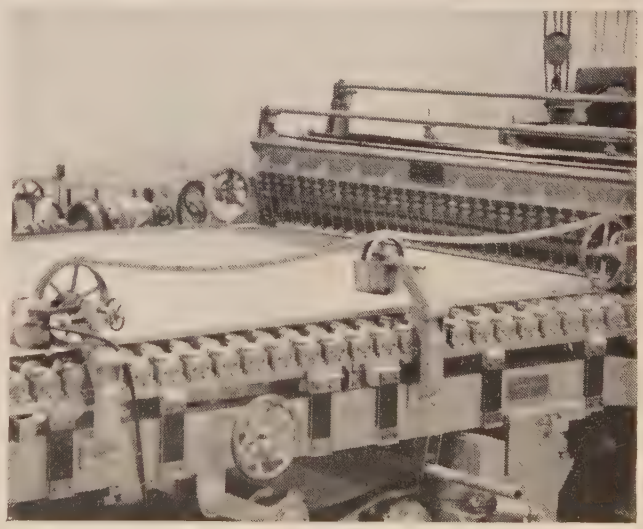
For the resistance of brass to corrosion is inherent. Brass rolls need no protection, no covering against attack by water or chemicals.

You can also count on brass rolls to stay clean—there's no tendency to pick up stock.

For rolls that are right in composition, fabrication, tolerances and finish—specify ANACONDA.

Our Technical Department can bring to your problem both its long familiarity with your special needs and its expert knowledge and skills in copper alloys. This service is yours merely by writing The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

50181



Fourdrinier section of paper machine with ANACONDA Brass Rolls.

PHOTOS COURTESY: RICE BARTON CORPORATION

For dependable paper production . . . use ANACONDA® BRASS ROLLS

Melvin J. Farris, Pulp Mill Superintendent of the Jacksonville mill, is transferred permanently to the Valdosta mill. During construction he will supervise installation of equipment and when the mill starts up will be Pulp Mill Superintendent in the Valdosta organization.

W. B. Hobbs, Assistant Pulp Mill Superintendent of the Jacksonville mill, will be promoted to Pulp Mill Superintendent of the Jacksonville mill.

J. C. Warnock, presently Wood Yard Operator, is promoted to Assistant Pulp Mill Superintendent of the Jacksonville mill.

H. M. Burnette, presently Assistant Maintenance Superintendent of the Jacksonville mill, is promoted to Maintenance Superintendent.

Allen H. Gridley, presently in the Jacksonville office of the Valdosta engineering organization, is transferred to Valdosta on the supervision of the construction of the mill. Mr. Gridley was formerly connected with Hardy S. Ferguson, Consulting Engineer of New York City.

B. H. Buck, Chief Engineer of Jacksonville and Valdosta mills, will continue in the Jacksonville office of the Valdosta construction organization, and Mr. Ralph Wood, Engineer in the Valdosta construction organization and responsible for purchasing and contractor contacts, will also remain in Jacksonville.

R. V. Pennington, formerly Maintenance Superintendent of the Jacksonville mill and presently a Lieutenant in the U. S. Navy, will, upon his return from the Navy, be permanently assigned to the Valdosta organization during construction, and after the mill starts operation.

S. L. Binns, Jr., presently in the Purchasing Department of the Jacksonville mill, will be transferred to Valdosta to assist J. M. Booth, who is presently assigned as Accountant on the construction job at Valdosta.

Chemical Engineering

Reinhold Publishing Co. recently published a book on *Chemical Engineering Techniques*, which is useful for vocational programs as a refresher for chemical engineers, operators, and maintenance men. B. E. Lauer of the University of Colorado, Boulder, Colo., a TAPPI member, is the author. Dr. Lauer has now prepared a set of 1152 slides which may be used by engineer-instructors in any plant to put on a full year's course, meeting an evening a week, with a minimum of outside work.

Chemical Congress

The XIIIth International Congress of Pure and Applied Chemistry will be held at Stockholm, Sweden, on July 29 to August 4, 1953. It will include a symposium on the chemistry of wood and wood constituents and macromolecules.

Paper and Graphic Arts

The Third International Paper and Allied Trades Equipment Exhibition will be held at the Exposition Park, Porte de Versailles, Paris, France, on Oct. 23–31, 1952.

Nekoosa-Edwards

All corporate officers of the Nekoosa-Edwards Paper Co. were re-elected. These include John E. Alexander, President and General Manager, Neil E. Nash, Vice-President, Adam C. Remley, Vice-President in Charge of Sales, Charles H. Reese, Vice-President in Charge of Manufacture, Samuel A. Casey, Secretary, and Walter A. Radke, Treasurer. A modernization program for the Port Edwards, Wis., mill will increase its capacity from 115 to 140 tons per day. The development includes a change in cooking methods from the calcium base to a soluble base cooking method.

Ohio Boxboard

At the Director's organization meeting Ohio Box Board Co. elected the following officers: Wayne Young, President; M. E. Barthen, Administrative Vice-President; F. O. Kanehl, Vice-President, Finance, and Treasurer; J. N. Andrews, Vice-President, Sales; J. C. Morris, Vice-President, Production; R. E. Young, Secretary.

Annual Reports

From the 5000 corporation annual reports for 1951, 30 pulp and paper companies were cited by *Financial World* for Merit Awards. These were: Abitibi, Bathurst, Brown, B. C. Forest Products, Carpenter, Champion, Consolidated Water Power & Paper, Crown Zellerbach, Donohue Bros., Eastern, Fraser, Great Northern, Hammermill, Hoberg, Hudson, International, Kimberly-Clark, Mead, Nekoosa-Edwards, Oxford, Powell River, Puget Sound, Rhinelander, Riegel, Rolland, St. Lawrence, St. Regis, Howard Smith, S. D. Warren, and West Virginia.

St. Regis

St. Regis Paper Co. has acquired the management and cutting rights for a period of 60 years of a tract of 47,500 acres of long-leaf and slash pine in Madison and Hamilton counties in Florida.

Economic Growth

In its July, 1952, issue, *Chemical Engineering* features Chemical Engineering's 50th Anniversary. In it are several references of interest to the pulp and paper industry. The industry's average annual rate of growth since 1929 has been 3.8%. In sales the industry ranks 11th with 6.8 million dollars. In consumption of chemicals it ranks 12th with 90 million dollars.

Pacific Lumber

With the appointment of William G. Van Beckum as Director of Research and Development, The Pacific Lumber Co. has announced plans to continue its development of chemical and fibrous redwood by-products that are applicable to the paper industry. In addition to their own research program, the firm has worked closely with The Institute of Paper Chemistry over a period of many years, and is currently cooperating with the Stanford Research Institute on a special series of developments.

Since 1948, Van Beckum has been Manager of Technical Service and Assistant Sales Manager, Special Products Div., Weyerhaeuser Timber Co. of Longview, Wash. A graduate of St. Norbert College and the University of Wisconsin, he worked under a TAPPI Fellowship for three years at the U. S. Forest Products Laboratory at Madison, Wis. In 1939 he joined the Wood Conversion Co., and 1942 became Chief of the Chemistry Section of the Weyerhaeuser Development Dept., of which he was named Assistant Manager in 1946.

Long recognized as a major producer of redwood lumber, The Pacific Lumber Co. has pioneered research in utilization of bark and other wood raw materials. The company's

William G. Van Beckum, The Pacific Lumber Co.

Tom R. Moore, General Dyestuff Corp.

PIPING...

from Soup to Nuts!!!

Power and Process Piping

Instrument Piping

Plumbing

Heating

Air Conditioning

Ventilation

Fire Protection Systems

Soup we can only heat and nuts we can only crack, but PIPING—that's our meat. As our two famous characters, "Torchy" at left and "Lockjaw", right, indicate, Huffman-Wolfe personnel are trained specialists in every phase of piping, welding and related fields. On new construction or on plant expansions, you can be assured of SINGLE RESPONSIBILITY for all types of piping, from the blueprint stage through final erection.

THE HUFFMAN-WOLFE COMPANIES

404-408 Sawtell Ave., S. E. ATLANTA
669 North High Street COLUMBUS, O.
4660 North Eighteenth St. PHILADELPHIA

chemical derivatives and other by-products are finding application in oil well drilling, leather tanning, and in the manufacture of ceramics, rubber, plastics, specialty papers, and additional industrial products. Redwood bark fiber insulation is one of the company's major by-products. Production facilities are located in Scotia, Calif., in the heart of the Redwood Empire. Van Beckum will make his headquarters at the firm's San Francisco office.

General Dyestuff

Tom R. Moore has been appointed Assistant to the Vice-President and General Sales Manager of the General Dyestuff Corp., New York, N. Y. Mr. Moore was Formerly Sales Service Manager for Antara Chemicals Div. of General Dyestuff Corp.

International Nickel

The International Nickel Co., 67 Wall St., New York 5, N. Y., has issued two new bulletins: "Building Up Worn Parts by Electrodeposition" and "Heat Resistant and Corrosion Resistant Alloy Castings in Industry."

Foxboro

The Foxboro Co., Foxboro, Mass.. has issued a new bulletin on Rapid Sand Filters Instrumentation and Control." Another bulletin (430-1) on "pH Control."

Babcock & Wilcox

The Tubular Products Div. of Babcock & Wilcox Co., Beaver Falls, Pa., has issued a new bulletin (TB-340) on "Seamless Mechanical Tubing," designed to help the tubing user in determining whether he should use hot finished, cold drawn, or "roto-rocked" seamless mechanical tubing.

Raybestos-Manhattan

Raybestos-Manhattan, Inc., has opened a new warehouse at Houston, Tex. The principal products carried will be conveyor belting, transmission belting, V belts, industrial hose, and asbestos and rubber packings. M. C. Nugent will be in charge of the warehouse, operating under the Dallas office.

Foster Wheeler

Foster Wheeler Corp., 165 Broadway, New York, N. Y., has issued a 32-page Bulletin (CT-52-4) on "Cooling Towers."

Rhoads

J. E. Rhoads & Son, 35 N. 6th St., Philadelphia 6, Pa., has issued a 40-page handbook on "Leather Belting" for the Pulp and Paper Industry. It includes information never before published.

De Laval

De Laval Steam Turbine Co., Trenton 2, N. J., has issued a new bulletin (2200) on "De Laval Crown Couplings." It gives information on construction, horsepower ratings, speeds, applications, and selection.

Black-Clawson (Shartle & Dilts)

The Black-Clawson Co. has established new and larger quarters at 685 W. Peachtree St., N. E. Atlanta 3, Ga. Edward M. Root is Southern Sales Manager and is assisted by Fred C. Jones, Sales Engineer.

Barrett

A new laboratory, specially designed to develop and test materials and processes used in the manufacture of plastics, rubber products, paints and varnishes, paper, laminates, and insulating materials has been opened by the Barrett Div., Allied Chemical & Dye Corp., at Edgewater, N. J. The laboratory will be known as the Shadyside Research Laboratory and will be in charge of D. A. Rankin, Superintendent. Barrett's products include phenolic resins, plasticizers, and protective coatings.

T. B. Calhoun, Oliver United Filters

Karl V. Rohlen, Crane Packing Co.

Oliver United

Oliver United Filters, 33 W. 42nd St., New York 36, N. Y., has issued a new bulletin (701-R) describing its line of Oliver drum-type and American disk-type savealls.

Oliver United has established a new territory serving the pulp and paper industry in Florida, Georgia, South Carolina, Mississippi, and Louisiana. T. B. Calhoun, formerly of the New York office has been assigned to this territory. He can be reached at P.O. Box 1518, Fair Hope, Ala.

Crane Packing

Crane Packing Co., Chicago, Ill., has elected Frank E. Payne, Chairman of the Board, and Karl V. Rohlen, President. Mr. Rohlen was formerly Vice-President and General Manager.

Link-Belt

Two Link-Belt traveling screens were recently delivered to the Consolidated Water Power & Paper Co.'s Interlake Mill at Appleton, Wis. These screens will supplement the fixed-position screen of coarser mesh that has been long in use. Water which floats pulpwood logs to the sawmill will flow through the traveling screens before going back into the river. Bark and other flotsam thus intercepted will travel on the screens to a trough, where a water shower removes it and sends it on its way for disposal. The total cost of the installation will be about $20,000.

Reliance

Reliance Electric & Engineering Co. has appointed four new engineers to district offices: James McC. Bigger to the Cleveland office, Burton B. Finegan to New York City, Walter A. Jensen to Buffalo, and William C. Prettyman to Chicago.

Westinghouse

Four sons of Westinghouse Electric Corp. employees were awarded $2000 War Memorial Scholarships by the firm so they can continue undergraduate study in the engineering or physical science fields.

Donald R. Jenkins has been appointed Manager of the newly formed Gas Turbine Application Engineering Section of the Steam Div. of Westinghouse at South Philadelphia, Pa.

GATX

W. J. Stebler has been elected Executive Vice-President of the General American Transportation Co., Chicago, Ill.

Gurley

W. E. Gurley, Troy, N. Y., has issued Bulletin 1400 dealing

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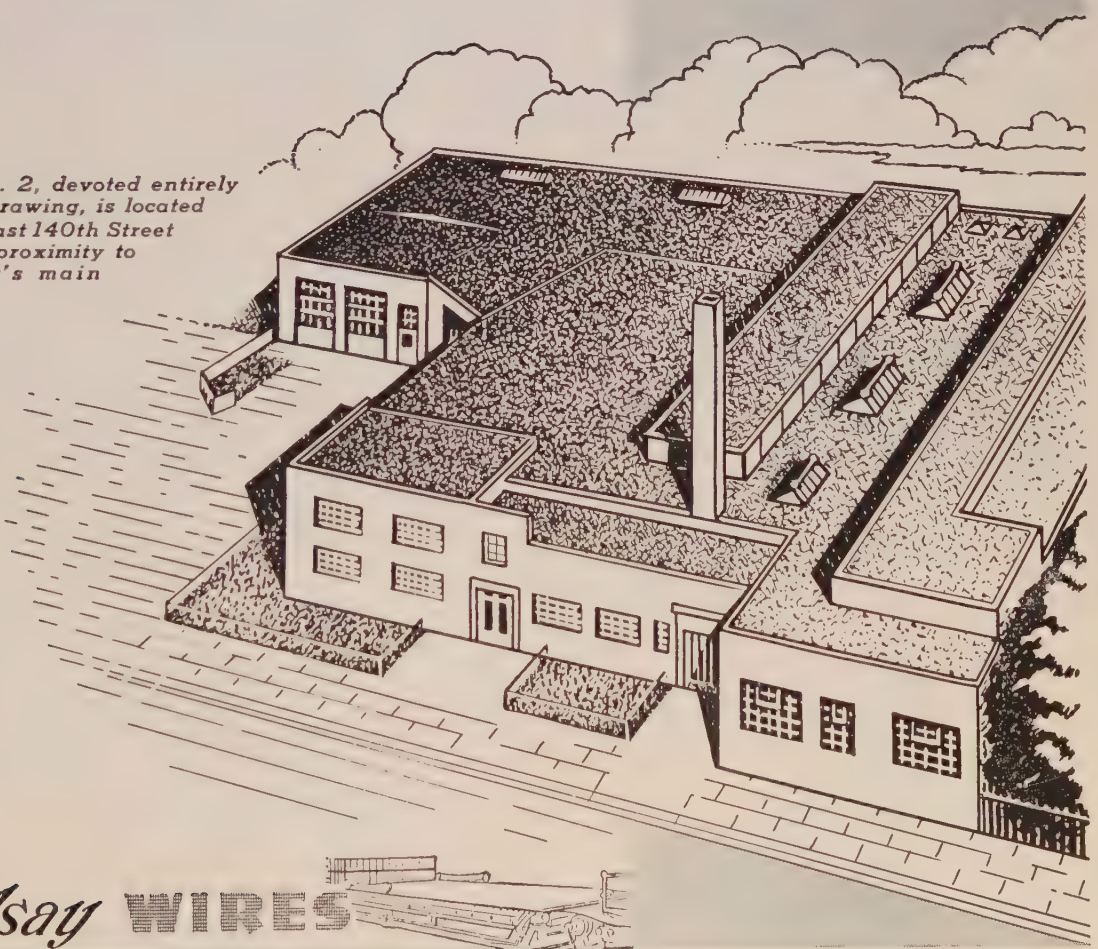
The quality of Lindsay Fourdrinier wires is still further assured. Wire drawing has become a completely integrated operation in Plant No. 2, laid out and specifically equipped for this single purpose. Thus the growth suggested at the left continues, but with unremitting reference to excellence and uniformity of product. The Lindsay Wire Weaving Company.

Plant No. 2, devoted entirely to wire drawing, is located at 835 East 140th Street in close proximity to Lindsay's main plant.



Lindsay WIRES FOR PAPER MILLS

SERVING THE PAPER INDUSTRY SINCE 1903

CLEVELAND 10, OHIO

with methods of testing paper, paperboard, plastics, and other sheet materials. The bulletin contains a table of "Air Resistance Equivalents" which helps the technician select the type of instrument best adopted to various materials.

DOW

A new revised booklet covering all phases of caustic soda has been issued by the Alkali Sales Dept., Dow Chemical Co., Midland, Mich.

Raymond F. Boyer has been appointed Manager of Dow's plastics and high polymer research.

MURRAY

D. J. Murray Mfg. Co., Wausau, Wis., has issued a new folder on "Grid" unit heaters.

ORR FELT

Norman B. Scott has moved from Piqua, Ohio, to join the Southern Territory staff of the Orr Felt & Blanket Co. Mr. Scott, who is well known in the paper industry will be located at 1452 San Amaro Rd., Jacksonville, Fla. Mr. Scott will cover the Southeast and George Witham, who is located at Mobile, Ala., will cover the mills in the Western half of the area.

GRATON & KNIGHT

Jackson L. Parker has been appointed advertising and merchandising manager of the Graton & Knight Co., Worcester, Mass.

ALLIS-CHALMERS

Allis-Chalmers Mfg. Co. has purchased the plant of Victor Electric Products, Inc., Cincinnati, Ohio. The new plant will permit an increase in capacity for the manufacture of Texrope drive equipment.

DU PONT

A new flexible valve shield made of neoprene synthetic rubber has been introduced for use on valves handling acids and other hazardous chemicals. The shield protects the operator from injury if the valve stem packing should fail. It cups the stem and the packing gland and prevents acid from spraying on the operator. They are called "Chex-spray" and manufactured by Industrial Products Co., 2820 N. Fourth St., Philadelphia 3. Pa.

Flexible valve shield prevents acid from spraying on operator

GENERAL ELECTRIC

The General Electric Co., Schenectady 5, N. Y., has issued an 8-page article reprint (G.E. R-594) describing the amplidyne-controlled elective log-carriage drives.

FLOX

The Flox Co., Inc., has transferred its office from 1132 N. W. Glison St. to 5329 N. E. Union Ave., Portland 11, Ore. Otto L. Hudrlik and J. M. James, Jr., are located at the Portland office.

MERRITT, CHAPMAN & SCOTT

Merritt, Chapman & Scott Corp. has leased the second floor of the new 22-story office building at 260 Madison Ave., New York, N. Y. M.C.&.S. have been located in the Whitehall Building since 1903.

OBITUARIES

Horace Albert Du Bois

Horace A. Du Bois, Chief of Pulp and Wood Preparation, Kimberly-Clark Corp., Neenah, Wis., died in Neenah on July 18 after a short illness.

Mr. Du Bois was born in Menasha, Wis., on June 12, 1900, and graduated in Chemistry from the University of Wisconsin in 1922.

He joined the Kimberly-Clark organization in 1922 and was sulphite superintendent at Niagara, Wis., until he was transferred to the Research Department in 1928. He was widely known as an authority in the sulphite pulp field and was the inventor of several processes in connection with the sulphite process. He was formerly Chairman of the Acid Pulping Committee of the Technical Association of the Pulp and Paper industry.

Norman Clark

Norman Clark, former paper industry chemist, died in Cincinnati, Ohio, on May 12, 1952. He was Chemist for the Continental Color Co., formerly affiliated with the International Printing Ink Co., from 1938 until his retirement in 1943.

Mr. Clark was born in Newcastle-on-Tyne, England, in 1890 and graduated in chemistry from the Massachusetts Institute of Technology in 1913.

Prior to joining the International Printing Ink Co. organization he was employed by the American Writing Paper Co., Nashua Gummed and Coated Paper Co., Whitmore Mfg. Co., and Pinco Papers, Inc.

He was, at one time, Chairman of the Coated and Processed Paper Committee of the Technical Association of the Pulp and Paper Industry.

Max Oberdorfer

Max Oberdorfer, 72, of Portland, Ore., and President of the St. Helens Pulp & Paper Co., St. Helens, Ore., was stricken fatally with a heart attack on July 26, 1952, at the International Airport, New York, N. Y., a half-hour after he arrived in the United States from Germany.

Mr. Oberdorfer was a graduate of Stuttgart and Munich Universities and at the time he joined the Technical Association of the Pulp and Paper Industry in November, 1915, the year the Association was organized, he was Engineer and Chemist for the Central Paper Co. in Muskegon, Mich. He was the founder and builder of the St. Helens Pulp and Paper Co. mills at St. Helens, Ore. Over the years he was helpful to many members of TAPPI, being generous in responding to a large number of the Association's technical inquiries.

Janet Macdonald

Janet Macdonald, 88, Mother of the TAPPI Secretary-Treasurer, died in Jamaica, N. Y. on September 2, 1952. She is survived by her daughter, Blanche, and two sons, Hugh and Ronald G. Macdonald.

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LOCAL SECTION ACTIVITIES

Reports of Meetings, Personnel and Events

Officers of Local Sections

The local sections will start their new seasons this month. Meetings are held during the year from September to June. The annual meetings are held usually in May or June, at which time the officers for the next season are elected. The officers who were elected for the 1952–53 terms are as follows:

Pacific

Chairman—Svarre E. Hazelquist, Pulp Div., Weyerhaeuser Timber Co., Longview, Wash.
Vice-Chairman—Fred J. Weleber, Publishers' Paper Co., Oregon City, Ore.
Secretary-Treasurer—H. B. Petersen, Hercules Powder Co., Portland, Ore.
Executive Committee—Officers and E. H. Nunn, Crown Zellerbach Corp., West Linn, Ore.; B. T. Briggs, Rayonier, Inc., Shelton, Wash.; R. M. True, General Dyestuff Corp., San Francisco, Calif.; E. O. Ericsson, Puget Sound Pulp & Timber Co., Bellingham, Wash.; J. M. McEwen, Pulp Div., Weyerhaeuser Timber Co., Everett, Wash.; and W. F. Holzer, Crown Zellerbach Corp., Camas, Wash.
Past-Chairmen—C. R. P. Cash, R. S. Wertheimer, C. W. Morden, R. B. Hansen, Lawrence Killam, M. W. Black, W. R Barber, Carl Fahlstrom, G. H. McGregor, N. W. Coster, F. A. Olmsted, C. E. Braun, E. P. Wood, C. A. Enghouse, Erik Ekholm, H. W. Bialkowsky, G. H. Gallaway, J. L. McCarthy, H. C. Wall, W. F. Holzer, R. I. Thieme, and E. O. Ericsson.
National Executive Committee Representative—W. F. Holzer, Crown Zellerbach Corp., Camas, Wash.

Lake States

Chairman—Herbert W. Rowe, Nekoosa-Edwards Paper Co., Port Edwards, Wis.
Vice-Chairman—Robert J. Seidl, Forest Products Laboratory, Madison, Wis.
Secretary—L. A. Moss, Whiting-Plover Paper Co., Stevens Point, Wis.
Treasurer—S. R. (Jim) Parsons, Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis.
Executive Committee—Officers and Reinhold A. Vogt, Combined Locks Paper Co., Combined Locks, Wis.; Gilbert K. Dickerman, Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis.; Karl W. Fries, Rhinelander Paper Co., Rhinelander, Wis.; and Donald MacLaurin, Institute of Paper Chemistry, Appleton, Wis.
Past-Chairman—G. K. Hill, Otto Kress, R. J. LeRoux, A. T. Gardner, S. D. Wells, J. R. Fauselow, H. W. Morgan, E. H. Voightman, R. A. Nugent, M. L. Downs, N. L. Malcove, J. H. Graff, T. R. Probst, J. P. Weidner, H. P. Dixson, L. V. Forman, C. J. West, Jr., A. M. Heald, G. R. Sears, H. C. Crandall, and Alan P. Adrian.
National Executive Committee Representative—H. F. Lewis, Institute of Paper Chemistry, Appleton, Wis.

Delaware Valley

Chairman H. C. Brill, E. I. du Pont de Nemours & Co., Newport, Del.
First Vice-Chairman—F. J. Lovegren, W. C. Hamilton & Sons, Miquon, Pa.
Second Vice-Chairman—E. R. Padavic, Container Corp. of America, Manayunk, Pa.
Treasurer—E. C. Molin, Glassine Paper Co., West Conshohocken, Pa.
Secretary—J. J. Steinbinder, Riegel Paper Corp., Milford, N. J.
Executive Committee—Officers and J. P. Weidner, Container Corp. of America, Manayunk, Pa., and A. S. Erspamer, P. H. Glatfelter Co., Spring Grove, Pa.
Past-Chairmen—W. R. Maull, G. E. Landt, H. P. Cannon, H. C. Schwalbe, J. d'A. Clark, C. M. Connor, E. J. Albert, J. D. Davis, W. M. Shoemaker, A. L. M. Bixler, John Macdam, J. P. Weidner, and A. S. Erspamer.
National Executive Committee Representative—W. D. Harrison, Riegel Paper Corp., Milford, N. J.

Kalamazoo Valley

Chairman—A. T. Luey, Sutherland Paper Co., Kalamazoo, Mich.
Vice-Chairman—R. H. Hurst, Kalamazoo Vegetable Parchment Co., Kalamazoo, Mich.
Secretary—J. A. Dean, Michigan Paper Co., Plainwell, Mich.
Treasurer—Richard Trelfa, Watervliet Paper Co., Watervliet, Mich.
Executive Committee—Officers and F. C. Goodwill, St. Regis Paper Co., Kalamazoo, Mich.; C. E. Mueller, Lockport Felt Co., Kalamazoo, Mich.; W. F. Hathaway, Kalamazoo Vegetable Parchment Co., Kalamazoo, Mich.; John R. Dam, Allied Paper Mills, Kalamazoo, Mich.; and J. A. Wise, Kalamazoo Paper Co., Kalamazoo, Mich.
Past-Chairman—M. D. Bardeen, E. F. Whittington, H. C. Bradford, C. C. Schneider, H. M. Annis, M. R. Wilkins, W. F. Hathaway, Paul de Guehery, W. A. Kirkpatrick, F. L. Chappel, F. D. Elliott, F. R. Hamilton, E. B. Taylor, R. C. Germanson, R. T. Mashburn, H. L. Mimms, P. W. Bartholomew, S. I. Kukolich, J. J. Harrison, and J. R. Dam.
National Executive Committee Representative—W. F. Hathaway, Kalamazoo Vegetable Parchment Co., Kalamazoo, Mich.

New England

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Vice-Chairman—F. S. Klein, Byron Weston Co., Dalton, Mass.
Secretary—P. D. Applegate, Hercules Powder Co., Holyoke, Mass.
Treasurer—H. T. Barker, Bird & Son, Inc., East Walpole, Mass.
Executive Committee—Officers and Miss Helen U. Kiely, American Writing Paper Corp., Holyoke, Mass.; Gordon Benson, St. Regis Paper Co., East Pepperell, Mass.; S. J. Quattrocchi, Deerfield Glassine Co., Monroe Bridge, Mass.; J. T. Loomer, Robert Gair Co., Inc., Uncasville, Conn.; George Soyka, Ft. Orange Paper Co., Castleton-on-Hudson, N. Y.; C. I. Horton, R. T. Vanderbilt Co., Inc., Norwalk, Conn.; George Wallace III, Fitchburg Paper Co., Fitchburg, Mass.; and Freeman Perry, Chemical Paper Mfg. Co., Holyoke, Mass.
Past-Chairman—F. C. Clark, R. C. Griffin, J. B. Calkin, R. H. Doughty, N. I. Bearse, W. L. Foote, L. B. Tucker, C. H. Child, P. S. Bolton, and R. J. Proctor.
National Executive Committee Representative—Milton Jacobs, Chas. T. Main, Inc., Boston, Mass.

Ohio

Chairman—C. E. Brandon, Howard Paper Mills, Dayton, Ohio.
Vice-Chairman—J. L. Clouse, Oxford Miami Paper Co., West Carrollton, Ohio.
Corresponding Secretary—Lee Buechler, Crystal Tissue Co., Middletown, Ohio.

S. E. Hazelquist, Weyerhaeuser Timber Co.; Chairman, Pacific Section

H. W. Rowe, Nekoosa-Edwards Paper Co.; Chairman, Lake States Section

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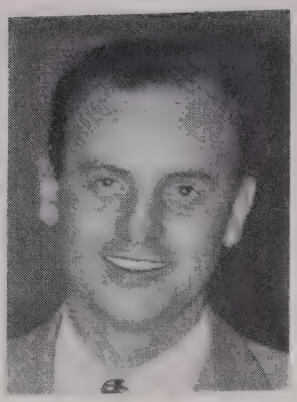

A. T. Luey, Sutherland Paper Co.; Chairman, Kalamazoo Valley Section

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Treasurer—R. D. McCarron, Stein, Hall & Co., Cincinnati, Ohio.
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National Executive Committee Representative—K. P. Geohegan, Howard Paper Mills, Dayton, Ohio.

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Chairman-Elect—D. Chace Mather, Carthage Paper Makers, Carthage, N. Y.
Secretary-Treasurer—Ralph N. Prince, American Cyanamid Co., Castleton-on-Hudson, N. Y.
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Past-Chairman—John H. Schuber, C. E. Libby, J. H. Rich, R. F. Huntley, F. C. Goodwill, H. D. Cook, F. J. Lang, W. O. Hisey, F. J. McCourt, H. A. Spencer, John Campbell, M. L. Jaffe, J. E. Foote, C. E. Foster, H. J. Perry, and J. S. Reichert.
National Executive Committee Representative—Ralph W. Kumler, American Cyanamid Co., New York, N. Y.

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Chairman—H. D. Cook, Sweet Bros., Paper Mfg. Co., Phoenix, N. Y.
Vice-Chairman—H. M. Gray, Sealright Corp., Fulton, N. Y.
Secretary—R. G. Hitchings, New York State College of Forestry, Syracuse, N. Y.
Treasurer—S. E. Church, New York State College of Forestry, Syracuse, N. Y.

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Vice-Chairman—J. W. Crocker, Sandy Hill Iron & Brass Works, Hudson Falls, N. Y.
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Secretary—F. P. Heil, Lockport Felt Co., Lockport, N. Y.
Treasurer—E. F. Andrews, International Paper Co., Niagara Falls, N. Y.

Maine-New Hampshire

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Vice-Chairman—Arthur E. Jones, Oxford Paper Co., Rumford, Me.
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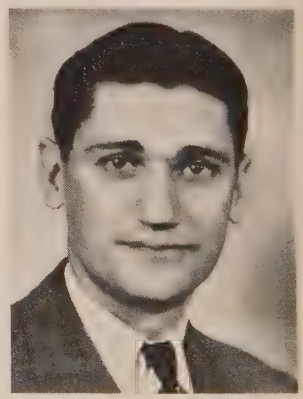
Secretary—L. E. Rolig, Ohio Boxboard Co., Rittman, Ohio.
Treasurer—E. F. Burke, Container Corp. of America, Cleveland, Ohio.
Financial Secretary—S. B. Gulliford, K. W. Lippert Co., Cleveland, Ohio.
Executive Committee—Edward Furlong, Container Corp. of America, Cleveland, Ohio; Arthur Cheeley, Hankins Container Corp., Cleveland, Ohio; L. K. Burnett, Ohio Boxboard

H. W. Knudson, Hollingsworth & Vose Co.; Chairman, New England Section



C. E. Brandon, Howard Paper Mills; Chairman, Ohio Section

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Past-Chairman—William Hasselo.
National Executive Committee Representative—L. K. Burnett, Ohio Boxboard Co., Rittman, Ohio.

Chicago

Chairman—V. V. Vallandigham, Kelco Co., Chicago, Ill.
Vice-Chairman—C. H. Krebs, Atlas Box-Makers, Chicago, Ill.
Secretary—J. J. McIntyre, H. B. Fuller Co., Chicago, Ill.
Treasurer—James D. Johnson, Container Corp. of America Chicago, Ill.
Executive Committee—Officers and Warren R. Price, Applie Research Service, Chicago, Ill.; M. W. Snover, Williamson Adhesives, Inc., Chicago, Ill.; Edward C. Berg, Ace Carton Co., Chicago, Ill.; C. S. Macnair, Acme Steel Co., Chicago, Ill.; A. L. Magnuson, Kelco Co., Chicago, Ill.
Past-Chairmen—H. R. Alley, H. E. Weston, F. D. Long, J. L. Kubicka, Warren R. Price, G. A. Zuikel, and Albert K. Roach.
National Executive Committee Representative—W. F. Hathaway, Kalamazoo Vegetable Parchment Co., Kalamazoo, Mich.

Southeastern

Chairman—G. C. Kimble, Union Bag & Paper Corp., Savannah, Ga.
Vice-Chairman—M. B. Pineo, Brunswick Pulp and Paper Co., Brunswick, Ga.
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Papermakers and Associates of Southern California

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Review of 1951–52 Section Meetings

The following is a record of the meetings held by the TAPPI local sections during the past year. Local section meetings begin usually in September and end in June. With the exception of outings and business meetings no meetings are held during July and August. A report of the meetings held during 1950–51 was published in the October, 1951, issue of *Tappi*.

Pacific

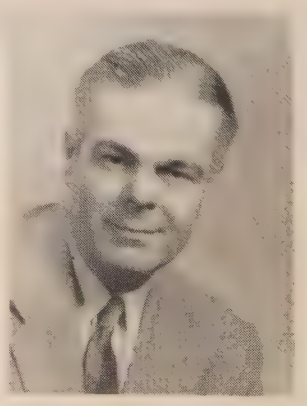
The Pacific Section was organized at Seattle, Wash., in June, 1929. The annual meeting is usually held in May.

Sept. 24–25 and 27–28, 1951 (at Portland, Ore., and Seattle, Wash., respectively): Fifth Annual Seminar on "Mechanical Properties of Paper," by Dr. Börje Steenberg, Swedish Forest Products Research Laboratory, Stockholm, Sweden.

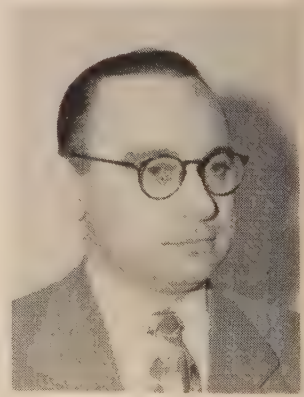
Sept. 26, 1951 (Bellingham, Wash.): Panel discussion on "Sulphur Recovery," J. M. McEwen, Weyerhaeuser Timber Co., Pulp Div., Everett, Wash., Moderator. (1) "Sulphur Savings at Camas," by J. V. Savage, Crown Zellerbach Corp., Camas, Wash. (2) "Pyrite Plants for Sulphite Acid," by A. Halvar Lundberg, Chemical Pulp Mill Engineer, Seattle, Wash. (3) "Sulphur Consumption at a Bleached Sulphite Mill," by Al Graef and J. T. Firestone, Pulp Div., Weyerhaeuser Timber Co., Everett, Wash. (4) "Semi-Chemical Pulping Characteristics of Pacific Coast Red Alder, Douglas Fir, Western Red Cedar and Western Hemlock," by J. N. McGovern, E. L. Keller, J. S. Martin, and R. M. Kingsbury, Forest Products Laboratory, Forest Service, Madison Wis. Paper delivered by R. J. Seidl of the Forest Products Laboratory, Madison, Wis. Dinner Meeting at Hotel Leopold, Bellingham, Wash. Dinner Speaker, Dr. Börje Steenberg.

Nov. 13, 1951 (Lower Columbia Junior College, Longview, Wash.): Annual Engineering Meeting, Donald G. Felthous, Pulp Div., Weyerhaeuser Timber Co., Longview, Wash., Moderator. (1) "Observation on Chip Handling from Barges and Cars," by L. E. Hill, Jr., Pulp Div., Weyerhaeuser Timber Co., Everett, Wash. (2) "Protection of Electrical Equipment Against Corrosion in Industrial Plants," by Harold E. Springer, Rayonier, Inc., Port Angeles, Wash. (3) "Pulp and Paper Operations Under the CMP Program," by James E. Maxwell, Business Economist, U. S. Dept. of Commerce. (4) "Substitution of Non-Critical Material in the Pulp and Paper Industry," by Donald M. Platt, Crown Zellerbach Corp., Camas, Wash. Dinner Meeting at Hotel Monticello, Longview, Wash. Dinner Speaker, Walter J. DeLong, Div. of Public Information, Weyerhaeuser Timber Co., Tacoma, Wash.

Jan. 15, 1952 (Olympia, Wash.): Panel discussion on "Process Control," Virgil M. Sutherling, Longview Fibre Co., Longview, Wash., Moderator. (1) "Instruments Are Cost-Cutters," by J. K. Gould, Longview Fibre Co., Longview, Wash. (2) "Automatic Firing of Hog Fuel," by C. H. Carter, Puget Sound Pulp & Timber Co., Bellingham, Wash. (3) "Graphic Panel Instrumentation," by R. D. Irwin, Minneapolis-Honeywell Regulator Co., Brown Instrument Div., Philadelphia, Pa. (4) "Radioisotopic Tracers in Industry," by Dr. J. H. Rediske, Nucleonics Dept., General Electric Co., Richland, Wash. Dinner Meeting at Olympian Hotel, Olympia, Wash. Dinner Speaker, Art



P. L. Haggerty, George La Monte & Son.; Chairman, Metropolitan District, Empire State Section



R. A. Premo, Gould Paper Co.; Chairman, Northern District, Empire State Section

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. . . explains why you can depend on Armstrong paper machine trap performance. Send for a copy.

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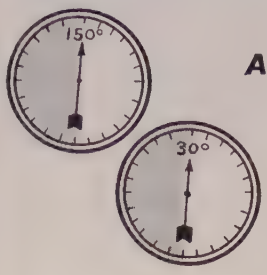

Automatically maintains dryer temperature at any point from 100°F to 250°F

THIS control mixes air with steam to maintain relatively cool wet end dryers. This prevents the sheet from sticking to the dryer surface and avoids curl or cockle due to overdrying on one side. The rest of the machine operates at maximum temperature.

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. . . explains the Control and its advantages. Write for a free copy.

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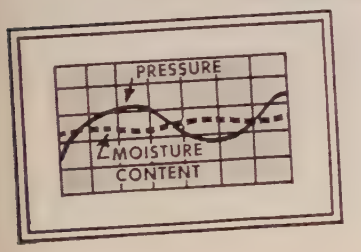

Automatically maintains very uniform sheet moisture content at any desired percent

THIS control maintains much more accurate sheet moisture content than is possible with hand control or constant steam pressure. It detects moisture content changes as the sheet passes over an "indicating dryer" and then varies steam pressure on the entire machine to compensate for the moisture variation.

BULLETIN NO. 196 ➧

. . . tells how the Moisture Control works, explains the specially designed components, lists the advantages. Send for your copy.

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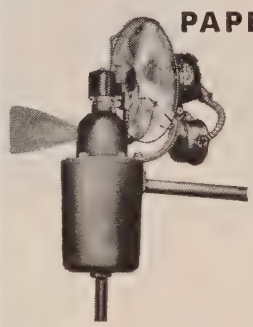

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. . . discusses relative humidity, gives data and prices on Armstrong Humidifiers, explains hookups, selection, etc. Send for your copy.

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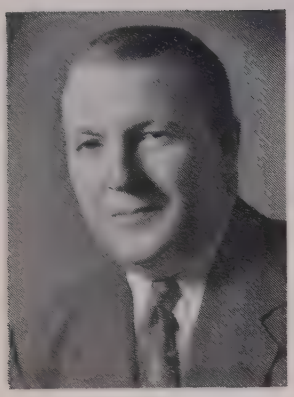


G. K. Storin, Niagara Alkali Co.: Chairman, Western District, Empire State Section

J. J. Thomas, S. D. Warren Co.; Chairman, Maine-New Hampshire Section

Anderson, Pres. Everett, Wash., Chamber of Commerce, posing as Dr. Axel Sven Soderblum of Karlstad, Sweden.

March 21, 1952 (Camas, Wash.): Annual Shibley Award Meeting. Program Chairman, R. I. Thieme, Soundview Div., Scott Paper Co., Everett, Wash. (1) "A Method for the Estimation of Decay in Douglas Fir Wool Chips," by Wesley L. Pearl, Longview Fibre Co., Longview, Wash. (2) "Sulphur Savings at Camas," by R. G. Stewart, Crown Zellerbach Corp., Camas, Wash. (3) "Sulphate Black Liquor Evaporator Tube Plugging Progress Report," by W. J. Hall, Weyerhaeuser Timber Co., Pulp Div., Springfield, Ore. (4) "Some Effects of Extreme Chip Packing in the Sulphite Process," by Alan S. Rosenfeld, Central Research Dept., Crown Zellerbach Corp., Camas, Wash. (5) "A Rapid Estimation of Calcium in Pulp," by LeRoy E. Smith, Rayonier, Inc., Hoquiam, Wash. Dinner Meeting at Crown Willamette Inn, Camas, Wash. Crown Zellerbach Corp. color film on "Forestry" shown.

Lake States

The Lake States Section was organized in Menasha, Wis., on Oct. 17, 1930. Meetings are usually held on the second Tuesday of each month at the Conway Hotel in Appleton, Wis., unless otherwise indicated. No meetings are held in December and February.

Sept. 20, 1951: "Influence of the Paper Machine on Paper Properties," by Börje Steenberg, Swedish Forest Products Research Laboratory; "Cooperative Research for the Pulp and Paper Industry in Australia," by W. E. Cohen, Commonwealth Scientific and Industrial Research Organization, Victoria, Australia.

Nov. 15, 1951 (Elks Club, Wisconsin Rapids, Wis.): Visit to Consolidated Water Power and Paper Co. mill. Panel discussion on "Hardwood Utilization," Clyde Faulkender, Technical Director of Hoberg Paper Mills, Green Bay, Wis., Moderator. (1) "Semichemical Pulping of Hardwoods," by Hu Miller, Green Bay Paper and Pulp Co., Green Bay, Wis. (2) "Pulping of Hardwoods by Modified Soda Process," by Paul West, Thilmany Pulp and Paper Co., Kaukauna, Wis. (3) "Refining and Developments in the Refining of Hardwoods," by C. K. Textor, Bauer Bros. Co., Springfield, Ohio. (4) "Kraft Pulping of Hardwoods," by George J. Brabender, Marathon Corp., Rothschild, Wis. (5) "Sulphite Pulping of Hardwoods," by Henry Grabowski, Falls Paper and Power Co., Oconto Falls, Wis.

Jan. 8, 1952: "Some Interesting Paper Machinery Developments," by Carl Swartz, Beloit Iron Works, Beloit, Wis.

March 11, 1952: "Beta-Gauge Control of Basis Weight," by J. A. Van den Akker, Institute of Paper Chemistry, Appleton, Wis.

April 8, 1952 (Powells, Rhinelander, Wis.): Visit to Rhinelander Paper Co. mill. Panel discussion on "Spent Liquor Utilization." J. R. Salvesen, Marathon Corp., Rothschild, Wis., Moderator. (1) "Why Stream Pollution from Waste Sulphite Liquor?" by K. W. Fries, Rhinelander Paper Co., Rhinelander, Wis. (2) "Present Status of Evaporation and Burning of Sulphite Waste Liquor," by N. L. Malcove, Northern Paper Mills, Green Bay, Wis. (3) "Torula Yeast from Sulphite Waste Liquor," by J. M. Holderby, Rhinelander Paper Co., Rhinelander, Wis. (4) "Road Binder Application and Results," by W. A. Sherman, The Kansas City Star Co., Flambeau Paper Div., Park Falls, Wis. (5) "The Recovery of Sodium Salts from Spent Liquors in the Neutral Sulphite, Semichemical Neutral Sulphite, Acid Sodium Sulphite, and Kraft Pulping of Wood," by S. D. Wells, Institute of Paper Chemistry, Appleton, Wis. Evening Address, "Impressions and Experiences During My Scandinavian Trip in Connection with ECA Mission," by Folke Becker, Rhinelander Paper Co., Rhinelander, Wis.

May 13, 1952 (Butte des Morts Country Club, Appleton, Wis.): A discussion on the National TAPPI organization and the part the local sections played in the national organization by K. P. Geohegan, President of National TAPPI and Vice-President of the Howard Paper Mills, Inc., Dayton, Ohio. Election of officers.

Delaware Valley Section

The Delaware Valley Section was organized at Philadelphia in June, 1931. Meetings are held monthly at the Engineers Club, Philadelphia, Pa., on the last Thursday of each month.

Sept. 21, 1951: Visit to W. C. Hamilton and Sons Paper Mill at Miquon, Pa. Dinner meeting at the Engineers Club. Panel discussion on "Recent Trends in Fourdrinier Machine Practice." R. Tourangeau, W. C. Hamilton & Sons, Miquon, Pa., Moderator. Panel members: B. L. Hammill, Beloit Iron Works; J. Baxter, Black-Clawson Co.; T. H. Latimer, Moore & White Co.; P. Andrew Jackson, Pusey & Jones Corp.; and Allen A. Lowe, Sandy Hill Iron and Brass Works.

Oct. 25, 1951: "Technical Control of Machine Production," by P. E. Nethercut, Scott Paper Co., Chester, Pa.

Nov. 29, 1952: "Color Engineering Point for Safety and Efficiency of Paper Production," by Dr. L. E. Whitmayer, E. I. du Pont de Nemours & Co., F. & F. Div.

Jan. 24, 1952: "Development of New Products for the Paper Industry," by Dr. A. L. M. Bixler, Riegel Paper Corp., Milford, N. J.

March 27, 1952: 20th Anniversary Meeting "Historical Background of the Delaware Valley Section," by E. J. Albert, Thwing-Albert Instrument Co., Philadelphia, Pa., and "Development of TAPPI and the Local Section," by K. P. Geohegan, National TAPPI President, Aetna Paper Co.

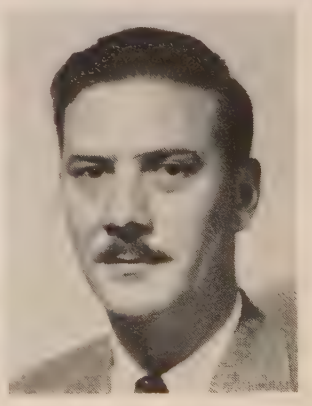
April 24, 1952: "We're Working While Rome Burns," by J. Q. du Pont, Public Relations Dept., E. I. du Pont de Nemours & Co., Wilmington, Del.

May 22, 1952: Presentation of Prize Papers of the "E. J. Albert Award." Winning Paper, "Air Heater and Economizers in Paper Mill Power Plants," by W. C. Marble, Riegel Paper Corp., Milford, N. J. Other papers presented were "White Water Utilization," by P. J. Schmitt, P. H. Glatfelter Co., "Continuous pH Control on a Glassine Machine," by R. C. Peterson, Riegel Paper Corp.; and "Technical Aids in a Paper Mill Felt Program," by Miss M. Willenbecker.

Kalamazoo Valley

The Kalamazoo Valley Section was organized at Kalamazoo, Mich., on May 4, 1931. Its meetings are held on the first Thursday of each month at either the Columbia or Harris Hotels, Kalamazoo.

Oct. 4, 1951: "Quality Control—Starch Control Method," by



V. V. Vallandigham, Kelco Co.; Chairman, Chicago Section

G. C. Kimble, Union Bag & Paper Corp.; Chairman, Southeastern Section

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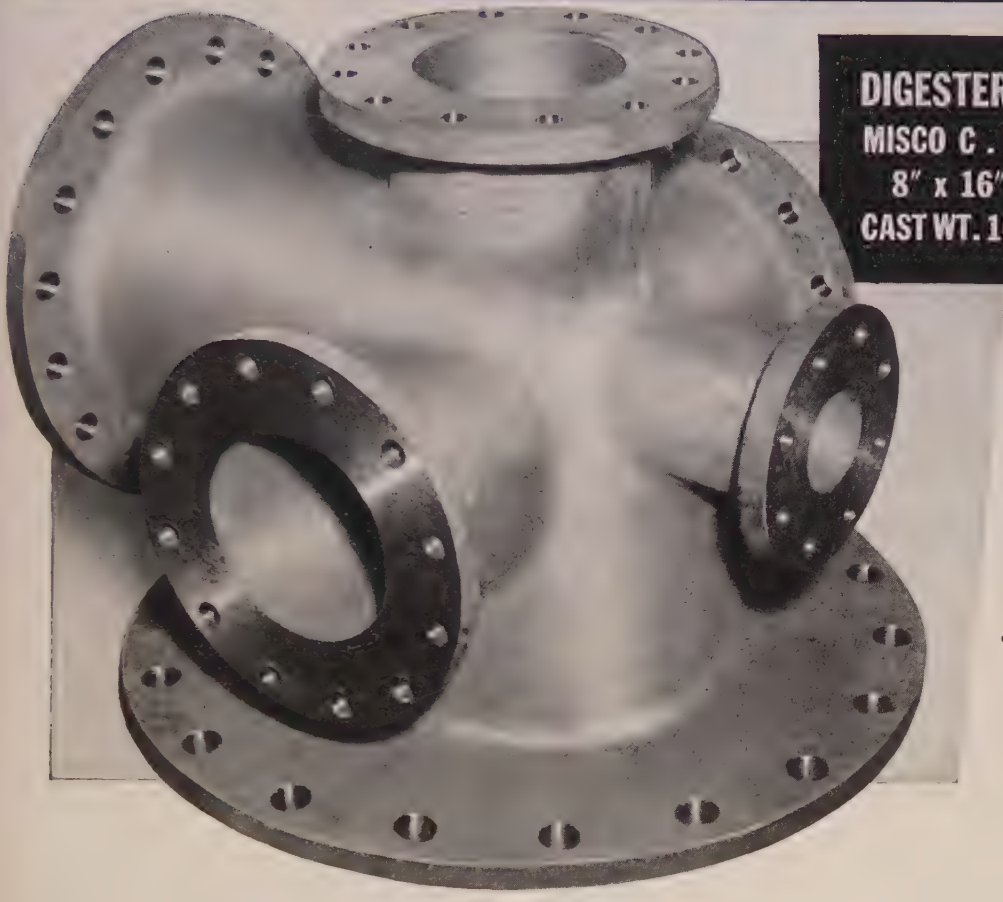

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Delaware Valley Section Officers: E. R. Padavic, Container Corp. of America; E. C. Molin, Glassine Paper Co.; H. C. Brill, E. I. du Pont de Nemours & Co.; F. J. Lovegren, W. C. Hamilton & Sons; and J. J. Steinbinder, Riegel Paper Corp.

Ray Hall, Allied Paper Mills; "Procedure for Operation of Sutherland Ink Rub Tester," by Martin Galbraith, Sutherland Paper Co.; "Method of Evaluating Wax Coverage on Cold Water Waxed Cartons," by Dr. J. J. Harrison, Michigan Carton Co.; "Rapid Method for Estimating the Dry Brightness of Pulp Slurry," by M. W. Kane, Kalamazoo Vegetable Parchment Co.; "Wet Rub Resistance of Paper Coatings," by Merle Wilkins, Kalamazoo Paper Co.; Tests for Iron," by W. L. Kite, Lee Paper Co.

Nov. 1, 1951: "Some Phases in the Development of Military Specifications on Paper and Paper Products," by E. T. A. Coughlin, Chief, Paper and Paper Products Unit, O.Q.M.G. Research & Development Branch.

Dec. 6, 1951: "Testing Procedures for Inks and Printing Surfaces," by Joseph Steinbruner, Plant Manager of Chicago Branch of International Printing Inks.

Jan. 10, 1952: "The New Challenge in the Paper Industry," by A. E. H. Fair, President of Alliance Paper Mills, Ltd., Toronto, Canada. Joint meeting with Michigan Div., American Pulp and Paper Mill Superintendents Assn. Fred C. Goodwill, Manager of St. Regis Paper Co., Kalamazoo, Mich., Toastmaster.

Feb. 7, 1952: "Paper Mill Effluent Control Using Filtration with Diatomaceous Filteraids," by G. G. Halvorsen, District Manager of Dicalite Div. of Great Lakes Carbon Corp.

March 6, 1952: "Surface and Internal Sizing"—Panel Members were J. P. Casey, A. E. Staley Manufacturing Co.; V. V. Vallandigham, Kelco Co.; Harold Sinclair, American Cyanamid; and Henry Heller, Hercules Powder Co.

April 17, 1952: "Multicolor Printing on Quality Coated Paper," by Dee James Andella, Illustrations Staff, *National Geographic Magazine*, Washington, D. C. Followed by panel discussion on "Coated Papers," by Merle R. Wilkins (Moderator), Kalamazoo Paper Co.; H. Ray Hall, Allied Paper Mills; Allen T. Luey, Sutherland Paper Co.; Harrison H. Kindig, Mac Sim Bar Paper Co.; Jack Marks, The Upjohn Co.; Glenn Davidson, Auora, Ill.; and L. H. Mimms, Kalamazoo Paper Co. Joint meeting with Michigan Div., American Pulp and Paper Mill Superintendents Assn.

May 1, 1952: Kalamazoo Valley Section Scholarship Award to Arne Anderson for highest scholastic record in Pulp and Paper Technology, Western Michigan College. Discussion of theses by graduates Don C. Burge, Theodore R. Kielts, Walter J. Redmond, Phillip H. Avery, Yale Brandt, Edward G. DeGalan, Edward J. Horvath, A. H. Anderson, Harvey Herman, William C. Geiger, Roderick A. Perkins, Rudolf Schmut, Daniel E. Bergsma, Arthur H. Hupp, Wayne E. Kendrick, and Richard E. Hathaway.

June 6, 1952: Annual Outing and "Fun Day," Gull Lake Country Club, Kalamazoo, Mich. Election of officers.

New England

The New England Section was organized at Holyoke, Mass., on Dec. 9, 1932. The following meetings were held during the current year:

Oct. 5, 1951 (Berkshire Inn, Great Barrington, Mass.): Geoffrey Broughton, Head of Dept. of Pulp and Paper Chemistry, Lowell Textile Institute, Lowell, Mass., discussed "Effect of Drying on Dimensional Stability of Paper."

Nov. 16, 1951 (Hotel Roger Smith, Holyoke, Mass.): "The Advantages and Disadvantages of Paper Machine White Water Utilization," by J. F. Baigas, Jr., New England Resident Engineer for National Council for Stream Improvement.

Jan. 18, 1952 (Hotel Roger Smith, Holyoke, Mass.): "Government Specification for Barrier Materials and Their Application in Military Packaging," by Roy H. Wood, Chief of Packaging Section of Dept. of Army, Picatinny Arsenal, Dover, N. J.

March 21, 1952 (Cloverhill Restaurant, Fitchburg, Mass.): Symposium on "Deinking" with Dr. Alfred H. Nadelman of Western Michigan College acting as Moderator. Panel Members: P. S. Bolton, Robert Gair Co., Inc., New London, Conn.; Francis R. DiFranco, National Adhesive Corp., New York; Fred C. Goodwill, St. Regis Paper Co., Kalamazoo, Mich.; Robert Graham, Graham Paper Stock Co., Fitchburg, Mass.; J. F. Baigas, Jr., New England Resident Engineer for the National Council for Stream Improvement, gave a few remarks.

May 16–17, 1952 (Toy Town Tavern, Winchendon, Mass.): "Business Papers," Harry O. George, International Business Machines, Endicott, N. Y.; "Permanent Papers," by Lewis S. Reid, Metropolitan Life Insurance Co., New York City; "Electrical Papers," by Philip L. Staats, General Electric Co., Pittsfield, Mass.; "Packaging Papers," by Charles Woodcock, General Foods, Inc., Hoboken, N. J.; "Trends in Papermaking," by John L. Calkins, University of Maine, Orono, Me.; "The Practical Man Vs. the Technical Man," by A. E. Bachmann, Missisquoi Corp., Sheldon Springs, Vt.

Ohio

The Ohio Section was organized on Nov. 30, 1934, at Middletown, Ohio. Meetings were held during the past year at the Manchester Hotel in Middletown unless indicated otherwise in the following list.

Oct. 8, 1951: "The Effect of Paper Machine Variables on Properties of Paper," by Dr. Börje Steenberg, Dean, Graduate School of Chemistry, Swedish Royal Institute of Technology and Director of Research, Paper Technology Dept., Swedish Forest Products Research Laboratory, Stockholm, Sweden.

Nov. 8, 1951: Combined meeting with Miami Valley Superintendents Assn., held at Hartwell Clubhouse, Cincinnati, Ohio. W. C. Bloomquist, General Electric Co., Schenectady, N. Y., spoke on "Gas Turbine Application in the Paper Mill."

Dec. 11, 1951: "Static Electricity," by L. E. Walkup, Battelle Memorial Institute. Meeting held at the Battelle Institute in Columbus, Ohio, preceded by tours of the Institute and Pollack Paper Co. mill, also in Columbus, Ohio.

Jan. 10, 1952: "Paper Packaging," Paul Cope, Procter & Gamble Co., Cincinnati, Ohio. Followed by film "The Magic Box," produced by Folding Paper Box Assn.

Ohio Section Officers: front: Lee Buechler, Crystal Tissue Co.; J. L. Clouse, Oxford Miami Paper Co.; C. E. Brandon, Howard Paper Mills; G. B. Gregg, Cincinnati Gas & Electric Co.; rear: Arthur Thurm, Champion Paper & Fibre Co.; M. G. Lyon, Champion Paper & Fibre Co.; H. A. Smith, Mead Corp.; and R. D. McCarron, Stein, Hall & Co.

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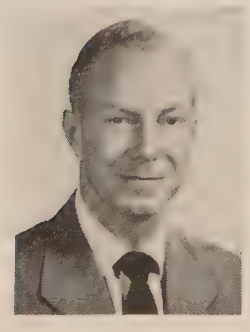

R. C. Trundle

PRESIDENT

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Feb. 12, 1952: "Tests and Test Procedures." Reports on section's committee on testing activities presented by C. E Brandon, Howard Paper Mills, and Harold Koch, Western Paper & Manufacturing Co. Prior to the meeting demonstrations and exhibits of testing equipment were presented by equipment manufacturers.

March 13, 1952: "Research Is Disturbing," D. C. Everest, Marathon Corp. Joint meeting with Cincinnati Club of Printing House Craftsman.

April 8, 1952 (Chillicothe, Ohio): Plant tours of Mead Corp. and Chillicothe Paper Co. mills. Mr. C. L. Clark, Clark and Vicario Co., spoke on the "Operation and Performance of the Deculator."

May 8, 1952: Annual meeting and entertainment. Election of officers.

Empire State

The Empire State Section began holding meetings in 1935, and received its charter on April 2, 1938. In 1943, the Section was reorganized on a regional basis with meetings being held in four districts (Central, Eastern, Northern and Western) of New York State. In 1948, the Metropolitan District was added.

Annual Meeting

June 19–21, 1952, at Hotel General Brock, Niagara Falls, Ont. (This was a joint meeting with the Niagara Branch of the Technical Section of CPPA.)

Panel discussions: "Waste Paper—Its Growing Importance to the Paper Industry." Moderator, H. P. Bailey, International Paper Co., Niagara Falls, N. Y. (J. J. Forsythe, International Paper Co., Niagara Falls, N. Y., Acting Moderator); Earle Weaver, International Paper Co., New York, N. Y.; Haskell Stovroff, Buffalo Waste Paper Co., Inc., Buffalo, N. Y.; D. D. Uong, Fitchburg Paper Co., Fitchburg, Mass.; R. W. Hynes, Newton Falls Paper Mills, Inc., Newton Falls, N. Y.; J. Clouse, Oxford-Miami Paper Co., West Carrollton, Ohio; S. G. Stapley, Provincial Paper, Ltd., Thorold, Ont.; F. C. Goodwill, St. Regis Paper Co., Kalamazoo, Mich. "Mechanical Pulp—Its Expanding Applications in Paper Manufacture." Moderator, Lyman A. Beeman, Finch, Pruyn & Co., Inc., Glens Falls, N. Y.; L. T. Bradley, Beaver Wood Fibre Co., Thorold, Ont.; M. Jones, Ontario Paper Co., Thorold, Ont.; R. J. Auchter, Kimberly-Clark Corp., Niagara Falls, N. Y.; C. N. Hagar, Diamond Match Co., Plattsburg, N. Y.; J. C. McGovern, Forest Products Laboratory, Madison, Wis. "Recent Trends in Pulp Bleaching Processes." Moderator, Dr. Ferdinand Kraft, Marathon Paper Co., Marathon, Ont.; E. J. Thom, Howard Smith Paper Mills, Ltd., Montreal, Que.; R. A. Premo, Gould Paper Co., Lyons Falls, N. Y.; J. C. Wilson, Hammermill Paper Co., Erie, Pa.; G. H. Chidester, Forest Products Laboratory, Madison, Wis. "Quality Requirements by Paper Consumers." Moderator, R. J. O'Brien, Moore Business Forms, Niagara Falls, N. Y. John Brown, J. W. Clement Co.; H. M. Gray, Sealright Corp., Fulton, N. Y.; B. L. Corbett, R. L. Crane Co.; George Acheson, E. S. & A. Robinson Co.

Senior Dinner

May 2, 1952: The Second Annual Dinner for the seniors at New York State College of Forestry sponsored by the Empire State Section was held at the University Club in Syracuse, N. Y. Vance Edwardes, Consultant and Past-President of National TAPPI, gave a welcoming address to the seniors as they enter the paper industry.

Central District (University Club, Syracuse, N. Y., First Friday of Month)

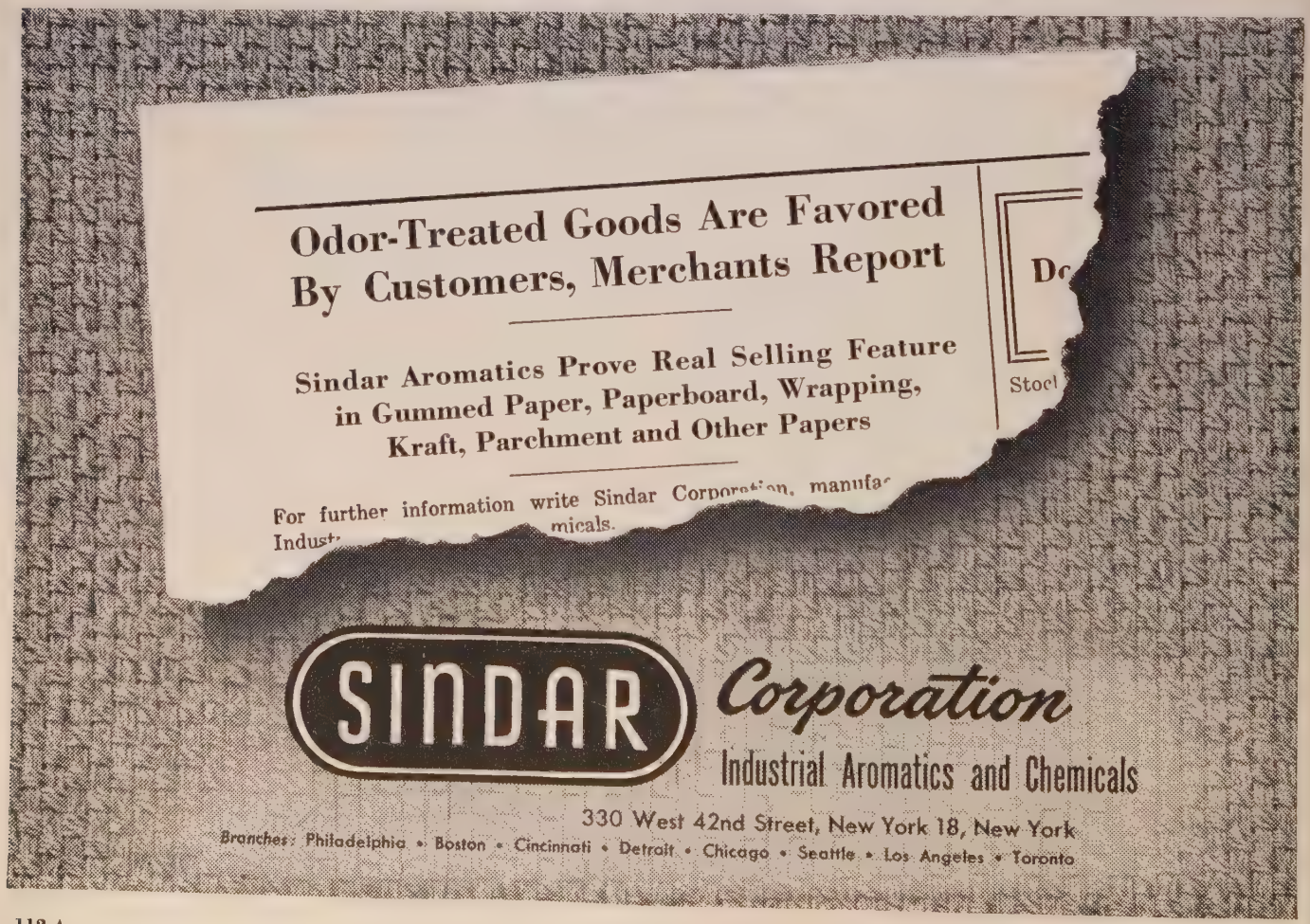
Oct. 5, 1951: "Paper Coating in the Manufacture of Paper Food Containers and Closures," by Clifford Morris, Sealright Corp., Fulton, N. Y.

Nov. 2, 1951: "Quality Control in the Manufacture of Paper Food Containers," by C. E. Foster, Jr., Sealright Corp., Fulton, N. Y.

Dec. 7, 1951: "Some Operating Characteristics of a Paper Machine Drier Section Equipped with Forced Circulation," by J. W. Oren, Armstrong Cork Co., Lancaster, Pa.

Jan. 11, 1952: "Problems of Cylinder Paper Machine Design and Operation," by H. D. Cook, Sweet Bros. Paper Co., Phoenix, N. Y.

Feb. 1, 1952: "The Effects of Shake in Low Speed Fourdrinier Operation," by Robert G. Hitchings, New York State College of Forestry, Syracuse, N. Y.; "The Application of Chlorine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Compounds in the Bleaching of Poplar Groundwood," by David Born, ESPRA, Syracuse, N. Y.

March 7, 1952: "Effect of Air Temperature on the Drying Rate of Bottle Cap Board," by D. B. Geffken, Oswego Falls Corp., Fulton, N. Y.

April 4, 1952: "Bark Removal by Chemical Treatment of Trees," by E. C. Jahn, New York State College of Forestry, Syracuse, N. Y.

May 2, 1952: Senior Dinner.

June 6, 1952: Ladies Night.

EASTERN DISTRICT (Milfrank's Restaurant, Lake George Rd., Glen Falls, N. Y., Third Thursday of Month)

Oct. 18, 1951: Panel discussion, "Stock Inlets." F. P. Doane, Jr., Sandy Hill Iron & Brass Works, Hudson Falls, N. Y., Moderator. P. A. Jackson, Pusey & Jones Corp., Wilmington, Del.; Paul Fasoli, Sandy Hill Iron & Brass Works, Hudson Falls, N. Y.; H. A. Norseen, Valley Iron Works, Appleton, Wis.

Nov. 15, 1951: "Stream Survey Program," by J. F. Baigus, Jr., National Council for Stream Improvement, New York, N. Y.

Dec. 13, 1951: Forum discussion of "Properties Needed in Paper to Meet Its Intended End Use." Moderator, R. E. March, Marinette Paper Co., Fort Edward, N. Y.; "Hanging Paper," by T. F. LaHaise, Imperial Paper & Color Corp., Plattsburg, N. Y.; "Printing Papers," by L. A. Beeman, Jr., Finch, Pruyn & Co., Inc., Glens Falls, N. Y., and H. H. Lavery, International Paper Co., Palmer, N. Y.; "Waxed Papers," by N. H. Rauscher, Diamond Match Co., Plattsburg, N. Y.; and "Toilet Tissue," by Wm. Spiller, Marinette Paper Co., South Glen Falls, N. Y.

Jan. 17, 1952: "Semi-Chemical Pulping of Hardwoods," by H. L. Field, West Virginia Pulp & Paper Co., Mechanicville, N. Y.

Feb. 14, 1952: "Materials Handling," by L. S. Phipps, Marinette Paper Co., Fort Edward, N. Y.

March 27, 1952: Panel Discussion on "Pitch Control." Moderator, C. N. Hagar, Jr., Diamond Match Co., Plattsburg, N. Y. "Pitch Control Problems," by D. D. Linehan, West Virginia Pulp & Paper Co., Mechanicville, N. Y.; "Notes on the Diamond Match Co., Pitch Treatment," by H. F. Jacques, Diamond Match Co., Plattsburg, N. Y.; "Can Pitch in a Paper Mill Be Controlled?" by R. A. Moynihan, Finch Pruyn & Co., Inc., Glens Falls, N. Y.; "Pitch Control," by F. J. McCourt, Jr., International Paper Co., Palmer, N. Y.

April 17, 1952: Ladies Night; Movie, "The du Pont Story."

May 22, 1952: "Some Operating Characteristics of a Paper Machine Drier Section Equipped with Forced Circulation," by J. W. Oren, Armstrong Cork Co., Lancaster, Pa.

METROPOLITAN DISTRICT (Fraunces Tavern, New York, N. Y., Second Tuesday of Month)

Sept. 11, 1951: Report on 43,000-mile world tour by E. J. Mayer, Jr., President, James Gray, Inc., New York, N. Y.

Oct. 9, 1951: "Technical Problems in Purchasing Non-fibrous Raw Materials," by A. V. Arenander, Jr., West Virginia Pulp & Paper Co., New York, N. Y.; "Purchasing of Fibrous Raw Materials," by J. A. Cauwels, Federal Paperboard Co., Bogota, N. J.

Nov. 13, 1951: Panel discussion concerning the purchase of paper by large users, with stress on specification buying and its technical aspects. Moderator, L. S. Reid, Metropolitan Life Insurance Co., New York, N. Y. "Purchasing of Paper by the General Electric Co. with Stress on Specification Purchasing and Its Technical Aspects," by R. H. Carter, General Electric Co., Schenectady, N. Y.; "Consumer Buying of Commercial Papers on Specification Basis by the Bell Telephone System," by W. H. Joy, American Telephone and Telegraph Co., New York, N. Y.; "Technical Aspects of Government Printing Office Paper Specifications," by M. S. Kantrowitz, Government Printing Office, Washington, D. C.

Jan. 8, 1952: "Functions of the Pulp, Paper, and Paperboard Division of the National Production Authority," by L. P. Nicolson, Deputy Director of the Division, Washington, D. C.

March 11, 1952: "The Importance of Merchandising," by Frank Lovejoy, Socony-Vacuum Oil Co., New York, N. Y.

April 15, 1952: "Manufacture of Containers and Container Boards," by A. G. Lynn, Robert Gair Co., New York, N. Y.

NORTHERN DISTRICT (Hotel Woodruff, Watertown, N. Y., Second Thursday of Month)

Oct. 11, 1951: "Impressions of a Traveling Engineer in the European Area," by J. W. Couture, Dilts Machine Works, Fulton, N. Y.

Nov. 8, 1951: "Conservation of Sulphur in Sulphite Mill

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Practice," by W. M. Orchard, G. D. Jenssen Co., Inc., Watertown, N. Y.

Dec. 13, 1951: "The Continuous Digester and Its Use for the Continuous Cooking of Chemical and Non-Chemical Pulp," by R. G. Goodwin, Paper & Industrial Appliances, Inc., New York, N. Y.

Jan. 10, 1952: "Climate's Effect on Paper Making," by A. C. Smith, Newton Falls Paper Mill, Inc., Newton Falls, N. Y.

Feb. 14, 1952: Paper Pedler's Party.

March 13, 1952: "Pumps for the Paper Industry," by H. K. Kingsbury, Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

April 10, 1952: "New York Forests and the Paper Industry," by A. B. Recknagel, St. Regis Paper Co., Deferiet, N. Y.

May 8, 1952: Ladies Night.

WESTERN DISTRICT (Prospect House, Niagara Falls, N. Y., First Wednesday of Month)

Oct. 3, 1951: "Publishing a Newspaper," by T. J. Berrigan, *Niagra Falls Gazette*, Niagara Falls, N. Y.

Nov. 7, 1951: "Evolution of Mill Type Slitters and Winders," by E. J. Ward, Cameron Machine Co., Brooklyn, N. Y.

Dec. 5, 1951: "A Practical Approach to Quality Control," by Howard Bolton, General Motors Corp., Detroit, Mich.

Feb. 6, 1952: Ladies Night.

March 11, 1952: "New Developments in Design and Operation of High Speed Paper Machines," by H. T. Fisher, Quebec North Shore Paper Co., Baie Comeau, Que.

April 2, 1952: "New Electrical Tools for More and Better Paper," by Walter Mikelson, General Electric Co., Schenectady, N. Y.

Maine-New Hampshire

The Maine-New Hampshire Section was organized at Orono, Me., on Oct. 25, 1940, and received its charter at Bangor, Me., on Oct. 26, 1945.

Oct. 5–6, 1951 (Louis Oakes Room, Library, University of Maine, Orono, Me.): "Basic Principles of Statistical Quality Control": (1) "Facts vs. Opinions," by Warren R. Purcell, Brown Co. (2) "Probability," by Arthur Bender, Jr., Delco-Remy Div., General Motors Corp. "Interpretation of Facts": (1) "Applications of Statistical Methods in the Pulp Mill," by F. L. Riley, Brown Co. (2) "Applications of Statistical Methods on the Paper Machines," by H. W. Cobb, S. D. Warren Co. (3) "Applications of Statistical Methods in the Coating Plant," by R. T. Trelfa, Hercules Powder Co. (4) "Applications of Statistical Methods to Research," by Paul M. Schaffrath, Oxford Paper Co. Panel discussion, R. T. Trelfa, Chairman, Hercules Powder Co. Panel Members: H. W. Cobb, S. D. Warren Co.; J. F. Langmaid, Jr., S. D. Warren Co.; Prof. Spofford H. Kimball, University of Maine; Warren R. Purcell, Brown Co.; Fred Riley, Brown Co.; Paul M. Schaffrath, Oxford Paper Co.

June 20–21, 1952 (The Belgrade Hotel, Belgrade Lakes, Me.): (1) "Problems of Clean Stock," by A. Jenkins, Sales Engineer, Bird Machine Co., East Walpole, Mass. (2) "The Oliver-Ahlfors Screen," by W. H. Pitkin, Oliver United Filters, Inc., New York, N. Y. (3) "Clean Stock with Centri Cleaner," by Edwin V. Kemp, Assistant Director of Laboratories, Bauer Brothers Co., Springfield, Ohio. (4) "Centrifugal Cleaning Equipment," by Mr. White, Shartle Bros., Middletown, Ohio. (1) "How Our Business Operates," by James P. Nolan, Training Director, Oxford Paper Co., Rumford, Me. (2) Moving picture, "The Forest and the Woodsmen." (3) Moving picture, "The Downington-Mason, Scott Super Cutter," presented by L. E. Smith, Downingtown Manufacturing Co., Downingtown, Pa.

INDUSTRIAL LECTURES AT THE UNIVERSITY OF MAINE

A program of visiting lecturers from industry has been completed for the fourth academic year at the University of Maine, as announced by Professor L. C. Jenness, Head of the Department of Chemical Engineering.

Forty-seven experts in various fields of pulp and paper manufacture and allied industries visited the University and lectured to groups of students taking courses in pulp and paper. The courses in Pulp Technology and Paper Technology were supervised by Professor John Lewis and a course in Pulp and Paper Mill Equipment was supervised by Charles M. Howell, Lecturer in Pulp and Paper Technology. These courses constitute part of the undergraduate requirements for the degree in Pulp and Paper Technology.

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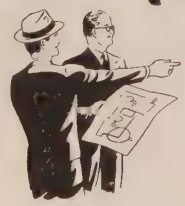

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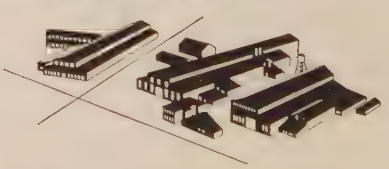

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The lectures were effectively presented by use of pictures, slides, charts, and samples. They were well received from the standpoint of student interest and effort. In expressing his appreciation to the sponsors of this program, Professor Jenness remarks that "the industry is to be commended for its cooperation in the prosecution of such an extensive adacemic program."

A list of the speakers and the subject discussed by them is as follows:

Pulp Technology

Carlin, T. J., Brown Co., Berlin, N. H., "Sulphate Pulping"; Coulter, J. H., Jr., Staff Engineering, The Babcock & Wilcox Co., Boston, Mass., "Soda and Sulphate Recovery"; Cousins, J. C., Chemist, Sulphite Div., Penobscot Chemical Fibre Co., Great Works, Me., "Chlorine Bleaching"; Daniell, W. F., Chief Engineer, Great Northern Paper Co., Millinocket, Me., "Manufacture of Groundwood-Grinders"; Douglass, I. B., Head, Dept. of Chemistry, University of Maine, Orono, Me., "Chemistry of Cellulose and Wood"; Field, H. L., West Virginia Pulp and Paper Co., Mechanicville, N. Y., "Soda Pulping"; Griffee, D. G., Pulp Mill Superintendent, Eastern Corp., Brewer, Me., "Sulphite Pulping–Acid Making Systems"; Harlow, F. B., Superintendent, Sulphite Div., Penobscot Chemical Fibre Co., Great Works, Me., "Sulphite Pulping—Cooking and Recovery"; Hyland, F., Botany Dept., University of Maine, Orono, Me., "Physical Properties of Wood"; Kloss, T. E., Assistant to Manager of Northern Mills, Hollingsworth & Whitney Co., Waterville, Me., "Manufacture of Groundwood—General"; Kraske, W. A., Technical Service, Solvay Process Co., Syracuse, N. Y., "Semi-Chemical Pulping"; Lewis, J., Assistant Professor, Chemical Engineering Dept., University of Maine, Orono, Me., "Wood Room"; McEwen, R. L., Research Chemist, Buffalo Electro-Chemical Co., Buffalo, N. Y., "Peroxide Bleaching"; Perry, H. J., Editor, *Paper Trade Journal*, 15 W. 47th St., New York 19, N. Y., "Woods Operations"; Uebrick, E. C., Sulphite Superintendent, St. Croix Paper Co., Woodland, Me., "Sulphite Pulping—Preparation of Sulphur Dioxide."

Paper Technology

Bolton, P. S., Research and Technical Director, Robert Gair Co., Inc., Uncasville, Conn., "Coarse Papers"; Casey, R. J., Industrial Products Dept., J. M. Huber Corp., 100 Park Ave., New York 17, N. Y., "Loading and Fillers"; Corbin, W. S., Chief Engineer, The Bagley & Sewall Co., Watertown, N. Y., "Fourdrinier Paper Machines—Wet End"; Davis, H. G., General Superintendent, Maine Coating Mills Div., Oxford Paper Co., Rumford, Me., "Coated Papers and Coating Processes"; Forman, L. V., Staff Director of Pulp Utilization, Scott Paper Co., Chester, Pa., "Paper Testing and Specifications"; Herbolzheimer, F., Assistant Superintendent, Pulp Preparation Dept., Scott Paper Co., Chester, Pa., "Stock Preparation"; Howell, C. M., Lecturer, Chemical Engineering Dept., University of Maine, Orono, Me., "Sanitary Tissues"; Jenness, L. C.,

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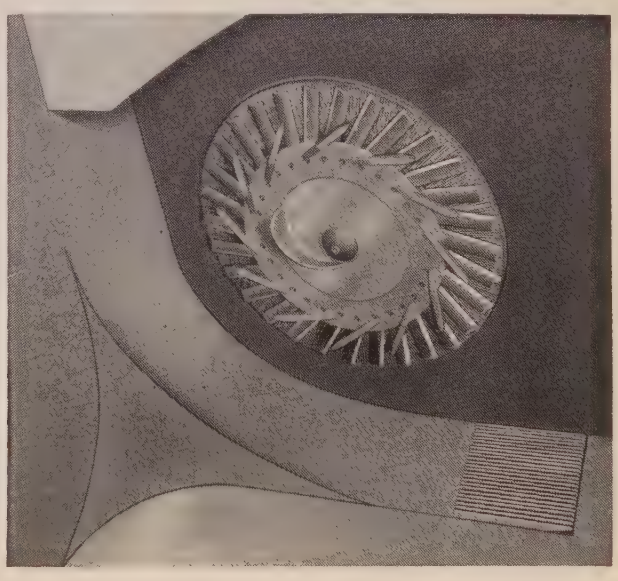

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Head Dept. of Chemical Engineering, University of Maine, Orono, Me., "Application of Ch.E. Unit Operations to Pulp and Paper Making"; Kiely, Helen U., Technical Director, American Writing Paper Corp., Holyoke, Mass., "Fine Writing Papers"; Lewis, J., Assistant Professor, Chemical Engineering Dept., University of Maine, Orono, Me., "Preview of Papermaking"; Lips, H., E. I. du Pont de Nemours & Co., Wilmington, Del., "Paper Coloring"; Newton, J. M., Director, Technical Sales Service, Clinton Foods, Inc., Clinton, Iowa, "Paper Sizing"; Redden, C. A., Chief Engineer, Hollingsworth & Whitney Co., Waterville, Me., "Fourdrinier Paper Machines—Dry End"; Reynolds, A. P., S. D. Warren Co., Cumberland Mills, Me., "Printing Papers and Processes"; Willey, B. L., Assistant Supervisor of Cutting, Finishing, and Loading Depts., West Virginia Pulp and Paper Co., Luke, Md., "Finishing and Converting"; White, P. J., Great Eastern Packing & Paper Stock Corp., 250 Park Ave., New York 17, N. Y., "Coarse, Papers."

Pulp and Paper Mill Equipment

Allman, L., J. O. Ross Engineering Corp., 79 Milk St., Boston, Mass., "Paper Machine Hoods—Hot Air Systems, Ventilation"; Bennett, R. A., Sales Engineer, Valley Iron Works, Appleton, Wis., "Inlets and Slices"; Faust, F. A., The Bristol Co., Waterbury, Conn., "Control of Paper Mill Operation with Instruments"; Fintak, G. G., Regional Hydraulic Specialist, Allis-Chalmers Co., 347 Park Square Building, Boston 16, Mass., "Stock Pumps, Selection, Operation, and Maintenance"; Hill, C. E., Engineer, The Pusey and Jones Corp., Wilmington 99, Del., "Dryer Systems, Selection, Operation, and Maintenance"; Hutchins, B. M., Chief Paper Mill Engineer, Rust Engineering Corp., Pittsburgh, Pa., "General Paper Mill Engineering"; Jenkins, A., Jr., Bird Machine Co., South Walpole, Mass., "Equipment for Cleaning Stock and Protecting Wires"; M. Justus, Engineer, Beloit Iron Works, Beloit, Wis., "Paper Machine Drives and Belts; Mechanical and Electrical"; Leighton, R. M., Chief Chemist, Stowe-Woodward, Inc., Newton Upper Falls 64, Mass., "Rubber Roll Coverings—Density, Thickness, Etc."; Pyle, C. J., Engineer, The Pusey and Jones Corp., Wilmington 99, Del., "Drier Systems, Selection, Operation, and Maintenance"; Muzzy, C. B., Sales Engineer, E. D. Jones Co., Pittsfield, Mass., "Stock Preparation Equipment"; Skeer, J. D., Felt Design and Process Control Engineer, F. C. Huyck & Sons, Kenwood Mills, Rensselaer, N. Y., "Felts—Selection, Operation, and Maintenance"; Smith, L. E., Sales Engineer, Downingtown Manufacturing Co., Downingtown, Pa., "Suction Rolls, Couch, and Press"; Stone, J. A., General Electric Co., District Office, Bangor, Me., "Motor and Electrical Equipment—Selection, Operation, and Maintenance"; Szepan, H. F., Improved Machinery Corp., Nashua, N. H., "Utilization of White Water and Saving Stock"; Teeple, H. O., International Nickel Co., 67 Wall St., New York, N. Y., "Stainless Steel and Corrosion—Prevention in Pulp and Paper Mills."

Chicago

The Chicago Section was organized as the Chicago Professional Paper Group in Chicago, Ill., in October, 1943. In 1946 the Group became the Chicago Section. All meetings are held in the rooms of the Chicago Bar Assn. on the third Monday of each month.

Sept. 17, 1951: "A Banker Looks at the Pulp and Paper Industry," by A. Newell Rumpf, Vice-President, Harris Trust & Savings Bank, Chicago, Ill.

Oct. 15, 1951: "Military Packaging," by Clinton K. Royce, Head, Packaging Section, Office of Navy Material, Washington, D. C.

Nov. 19, 1951: Joint Meeting with the Folding Paper Box Assn. of America. "Greaseproof Packaging—Papers, Coatings, Films-Foils." Moderator, F. D. Long, Chairman, Research & Technical Committee, Folding Paper Box Assn.; "Greaseproof Requirements," by H. T. Spannuth, Wilson & Co., Inc., Chicago, Ill.; "Fundamentals and Theories of Greaseproof Applications," by A. T. Luey, Sutherland Paper Co., Kalamazoo, Mich.; "Special Greaseproof Method and Formulation," by D. R. Erickson, Consultant, Kalamazoo, Mich.; "Polyethylene Coatings," by L. E. Whitemore, Bakelite Co., Chicago, Ill.; "Greaseproof Papers and Laminations," by M. L. Downs, Thilmany Pulp & Paper Co., Kaukauna, Wis.; and "Aluminum Foil and Paper Laminations in Packaging," by A. I. Totten, Jr., Director of Research, Reynolds Metals Co., Richmond, Va.

Jan. 21, 1952: 2nd Annual A to Z Corrugating Conference: Moderator, G. A. Zinkil, Special Representative, Central Fibre Products Co., Quincy, Ill.; "Component Materials Required,"

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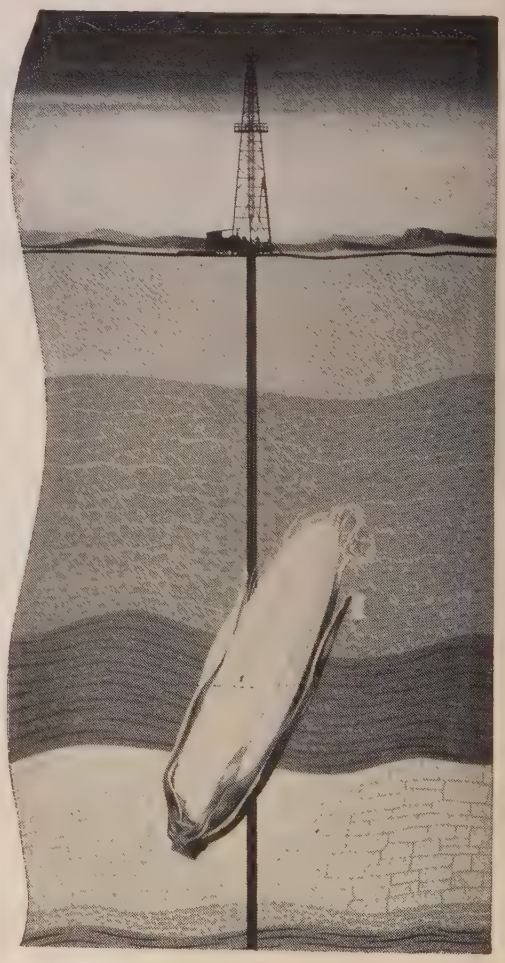


by G. A. Farrah, Assistant to the Vice-President, National Container Corp., Tomahawk, Wis.; "Operation of the Corrugator," by R. L. Cassady, Vice-President, The Jackson Box Co., Cincinnati, Ohio; "Technical Personnel Is Expensive," by H. J. Bettendorf, Vice-President, *Fibre Containers Magazine*, Chicago, Ill. "Quality Control in the Box Shop," by M. L. Hamilton, Technical Superintendent, Container Corp. of America, Chicago, Ill.; "How Costly Is It to Operate Your Modern Equipment with Horse and Buggy Methods of Handling Steam?" by Paul Harrison, President, Velocity Steam Production Engineering, Inc., Chicago, Ill.; and "The Customer Speaks," L. H. Grubbs, Buyer, Johnson & Johnson Co., Chicago, Ill.

Feb. 11, 1952: "Aniline Printing Enters the Carton Field," by Frank A. Dick, Assistant to the Executive Vice-President, International Printing Ink, Chicago, Ill.

March 17, 1952: "The Nature of Odor," by Ernest C. Crocker.

April 21, 1952: "Surface Sizing"—"Starches," by James Casey, A. E. Staley Mfg. Co., Decatur, Ill.; "Waxes," by Warren Kumblad, Socony-Vacuum Oil Co., New York, N. Y.; "Sodium Alginates," by Vance Vallandigham, Kelco Co., Chicago, Ill.; and "Carboxy-Methyl-Cellulose," by Harris Ware, Hercules Powder Co., Kalamazoo, Mich.

May 19, 1952: "What's Ahead for Business," by Alfred P. Haake, Mayor, Park Ridge, Ill.

June 10, 1952: Golf outing.

Lake Erie

The Lake Erie Papermakers and Converters Assn. was organized at the Hickory Grille, Cleveland, Ohio, on Oct. 7, 1949. Meetings are held on the third Friday of each month at the Hickory Grille, 929 Chester Ave., Cleveland, Ohio. This organization received its charter as the Lake Erie Section on May 18, 1951.

Oct. 19, 1951: "The Converter's Typical Problems," by P. H. McDowell, A. L. Garber Co., Ashland, Ohio, and R. O. Spaulding, Owens-Illinois-Glass Co., Toledo, Ohio.

Nov. 16, 1951: "Does a Training Program Pay?" by William Grier, Industrial Rayon Corp., Painesville, Ohio, and Stewart Drum, Container Corp. of America, Cleveland, Ohio.

Dec. 21, 1951: Christmas Party.

Jan. 18, 1952: "Aluminum Foil in Protective Packaging," by Dr. Thomas M. Hill, Aluminum Corp. of America, Pittsburgh, Pa.

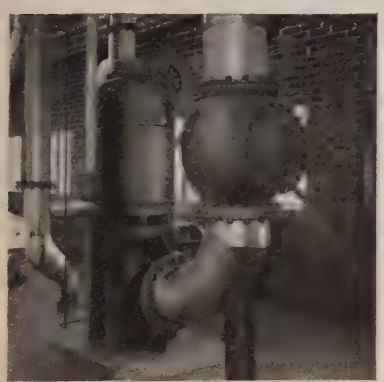
Feb. 15, 1952: "Cashing in on a Suggestion System," by Joe Harwood, Morton Suggestions Systems, Cleveland, Ohio, and Mel Goffinet, Ohio Boxboard Co., Rittman, Ohio.

March 21, 1952: "Aniline Printing Process," by Douglas E. Tuttle, International Printing Ink Div. of Interchemical Corp., Boston, Mass.

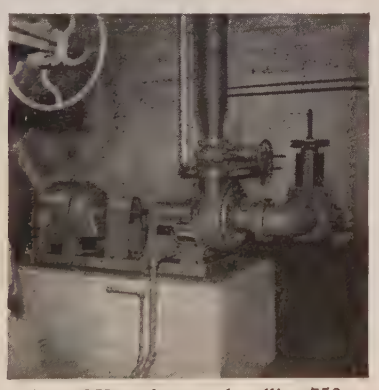
April 18, 1952: "A Demonstration of the Densichron and an Explanation of Color Control," by Dennis Heindel, Container Corp. of America, Cleveland, Ohio; "Instruments for Control of Folding Carton Quality," by J. J. Higgins, Ohio Boxboard Co., Rittman, Ohio, and "Color Control in Gravure Printing of Films and Paper," by R. F. Overmeyer, Shellmar Products Corp., Mount Vernon, Ohio.

May 23, 1952: Section jointly sponsored a full-day meeting with the Technical Committee of the Folding Paper Box Assn. of America as a "Folding Carton Forum." F. D. Long, Container Corp. of America, Chicago, Ill., Moderator (Morning Session). "Problems in Manufacturing Board for Folding Cartons," by J. P. Wiedner, Container Corp. of America, Philadelphia, Pa.; "Folding Carton Manufacturing Problems," by F. H. Stowitts, Michigan Carton Co., Battle Creek, Mich.; "Meeting the Customer's Requirements for Folding Cartons," by Walter Sooy, Gardner Board and Carton Co., Middletown, Ohio; Discussion Period, speakers, and Michael Zales, Great Lakes Box Co., Cleveland, Ohio, sitting as a panel. L. K. Burnett, Ohio Boxboard Co., Rittman, Ohio, Moderator (Afternoon Session); "Folding Cartons from the Consumer's Viewpoint," by W. L. Romney, Procter & Gamble, Cincinnati, Ohio; "Testing Procedures for Folding Cartons," by L. R. Ayers, Robert Gair Co., Piermont, N. Y.; "Development of Folding Cartons," by H. S. Gardner, Fibreboard Products Co., Antioch, Calif.; Discussion Period, Speakers, and Henry Bond, Richardson Taylor-Globe, Cincinnati, Ohio, sitting as a panel. W. Hasselo, Container Corp. of America, Cleveland, Ohio, Toastmaster (Evening Session); "Future of Folding Paper Cartons," by R. S. Irwin, Summerville, Ltd., London, Ont., Canada; "Cooperative Research for Industry Development," L. K. Burnett, Ohio Boxboard Co., Rittman, Ohio.

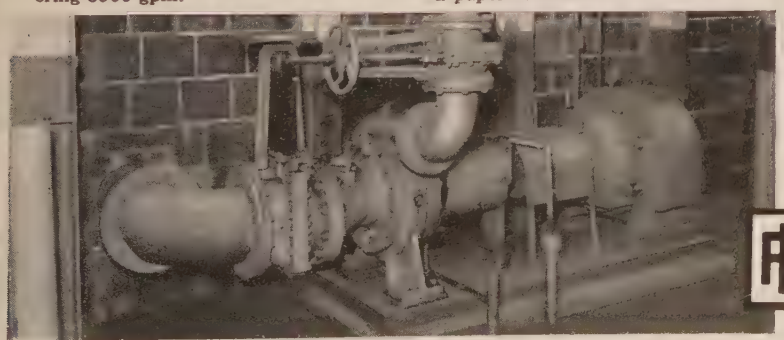
STOCK PUMPS? YES!



A 24 APH single-stage vertical pump used as a fan pump, delivering 8500 gpm.



A 4 FGV stock pump handling 750 gpm of stock from the couch pit of a paper machine.



This 8 HGV pump transfers 3½% stock from a beater dump chest to refiners at a southern mill.

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Southeastern Pulp and Paper Society

Sept. 14–15, 1951 (King and Prince Hotel, St. Simon's Island, Ga.): Second meeting of the Southeastern Pulp and Paper Society. Election of officers for 1951–52. "Further Discussion of a New Continuous Process for Kraft Pulp," by Dr. Wilson F. Brown, Research Director, Pulp and Paper Laboratory, University of Florida; "Hot Lime Zeolite—A Versatile Water Treatment Process," by Louis Wirth, Jr., National Aluminate Corp.; "A Method of Inventorying Straw-Piled Wood," by George Seymour, Brunswick Pulp and Paper Co. Tour of mill, Brunswick Pulp and Paper Co.

Nov. 30, 1951 (George Washington Hotel, Jacksonville, Fla.): "Improved Diffuser Operation," by H. T. Robson, Process Engineer, Union Bag & Paper Corp., Savannah, Ga.; "Problems Related to the Evaluation of the Degree of Delignification," by Dr. P. B. Borlew, Technical Director, Container Corp. of America, Fernandina, Fla.; "Paper—The Pacemaker of America," sound film courtesy of F. C. Huyck & Sons. Tour of mill, Container Corp. of America, Fernandina, Fla.

March 21, 1952 (DeSota Hotel, Savannah, Ga.): Program built on by-products of kraft industry: lignin, bark, turpentine. "The Use of Lignin in Rubber," by Paul R. Wiley, Director of Development, West Virginia Pulp and Paper Co., Charleston, S. C.; "Some Observations in Sulphate Turpentine Recovery," by M. R. Dusenbury and J. E. Reese, Hercules Powder Co., Brunswick, Ga.; "Suspension Burning of Bark Refuse," color film, narration by Carl E. Miller of Combustion Engineering-Superheater, Inc. Tour of mill, Southern Paperboard Corp., Port Wentworth, Ga.

May 23, 1952 (Fort Sumter Hotel, Charleston, S. C.): Annual meeting. Election of officers, 1952–53. Program built around stream improvement. "The State's Views of Steam Improvement by the Pulp and Paper Industry," by David B. Lee, Sanitary Engineer, State Board of Health of Florida; "National Council for Stream Improvement Activities," by W. A. Moggio, Southern Resident Engineer and Project Leader, National Council for Stream Improvement, Louisiana State University; "Stream Pollutional Aspects of the Kraft Pulping Industry," by David B. Smith, Associate Professor of Civil Engineering, University of Florida. Tour of mill, West Virginia Pulp and Paper Co., Charleston, S. C.

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Presented at National and Regional Conferences

Sixth Engineering Conference

EDITOR'S NOTE: It is suggested that in the review of these meeting minutes reference be made to pages 94 A to 108 A in the Nov., 1951, issue of *Tappi*. The discussions are in the order given in this report of the conference.

Mill Design and Economic Aspects

MR. PACKARD: There is one announcement that I want to make with regard to the Mill Design and Economic Aspects Committee. You men will note upon looking at the program and possibly reading the abstracts that the two papers and the panel session cover only one half of what is meant in the title of the committee. In other words, it is on the economic aspects portion. Those of you who were in Boston two years ago will recall that there was a paper on mill design by Mario C. Celli and it was thought by the committee that it was a very good paper and would be satisfactory if we skipped a year before entering into that part of the responsibility of the committee. In other words, it is my intention to ask you gentlemen assembled here to take this remark rather seriously and if you think of some angle of mill design or the subject in general that you would like to have a paper written on I would be most happy to receive that suggestion. You can address me at TAPPI in New York City and it will be forwarded to me.

I am certainly grateful for the good representation here this afternoon showing an interest in the papers to be presented. This first paper is entitled "Pump Difficulties in Pulp and Paper Mill." It is to be given by Parkman A. Collins of the Warren Steam Pump Co. of Warren, Mass. It is a great pleasure for me to introduce the man to you who has spent a lifetime in the design, application, and the sale of pumps in pulp and paper mills and with this kind of a background I am asking Mr. Collins to present his paper.

"Pump Troubles with Mixed Furnishes," by Parkman A. Collins (*Tappi* 35, No. 2: 102 A (Feb., 1952)).

MR. COLLINS: I might add that this subject, of course, melds in with the panel discussion that will take place later. Apparently in making some special grade they have used additives which may be in the form of a size or something they compounded themselves. I happen to have picked up a paper that was given to TAPPI sometime ago but which I saw only the other day, where a very good pump man in Canada mentioned, and perhaps some of you other pump men have had experiences with, submergence of ten feet, short direct connections, and still you couldn't pump. We have had a few.

ANON.: What kind of stock?

MR. COLLINS: I can't tell you because they conceal the kind of stock. I had one case up in New England where they got me up in the middle of the night and I held this pump's hand for two days and two nights. We did about five things and finally it did pump but, unfortunately, we did a couple of things at the same time and we didn't know which one did the trick. In one case I can tell you where we did find out a little bit about the stock. In that case the superintendent said "Don't worry about this as it will never happen again. I will not tell you what we put in the stock but just don't worry as it will never happen again." In another case not too long ago, we had identical layouts on two different machines supposed to be the same stock but the machines were identical. The jordan-machine chest layout to the machine was all exactly the same. One pump had been in for some time and no difficulty was encountered. The second pump went in and we had difficulty. Digging into it, of course, we claimed there must be some difference and finally the head mechanical man said let us go look at the papermaker's formula and there was the difference. On one finish there was four pails of size, which was on the one that was working all right. On the other one there was fourteen pails of size. I am not a chemist and I don't know much about those things. There are, of course, stocks that have given troubles over a period of years. Some of these high colors, oily colors, turkey red, chrome yellow, are an old problem but there appear to be new problems developing with special additives that occasionally give trouble. I wish somebody would tell me just which they are.

MR. WEIL: Do you have these complaints with a vertical submerged pump and if not why don't you concentrate on the design of a good vertical pump?

MR. COLLINS: That is a good question. We happen to be the first ones to design a vertical top suction pump. It was born on a tablecloth in Bangor, Me., and two pumps were built for Great Northern many years ago of that type. We were the first to build a vertical top suction condensate pump, both of which are good because the eye of the impeller is in a horizontal position. Vertical eye looking upward the gas tends to escape immediately and the eye is always flooded with whatever liquid there is available. We would not have the same trouble with a vertical top section pump on those jobs but, unfortunately, there are very few of those pumps and I myself never recommend a vertical pump when it is possible to do the job well with a horizontal pump. The horizontal pump is so much simpler, more accessible, etc. Does that answer your question Mr. Weil?

ANON.: How can you stop surging in a fan pump?

MR. COLLINS: Yes, it is a familiar problem the one you mentioned, the surging in a fan pump. There is pretty apt to be a lot of the old entrained air nuisance problem on a fan pump. Quite often the opening of the downpipe from a pit may not be sufficiently covered. I have found on a number of occasions—one in New England on a very large machine where there was only about 20 in. over the downpipe and it was a 24-in. pipe. Naturally, you are going to have a lot of air go down and you have seen some papermakers who have a baffle or cross in the downpipe to prevent the swirl. Of course, if you look in the book I believe it says that pipe should be covered by five pipe diameters. Of course, that is impractical. We can't get that but I know some papermakers who say there never should be less than 28 in. Then, of course, you have your fresh stock going down a pipe to join the suction of the fan pump and oftentimes there is a source of air there. You can look for all those things and you can look for the tray water plunging in which may carry a lot of air down into the pit. After doing the best you can with the submergence and keeping air from getting in then the next thing to do to prevent surging, whether you are pumping to an open headbox or to a pressure box, is to vent the suction chambers of the fan pump. It is impossible to get air out of moving water in the suction chamber unless the opening is a good size. When we build a double suction fan house we usually, on nearly all of them, put a box on each suction chamber and sometimes have the vent connection already drilled

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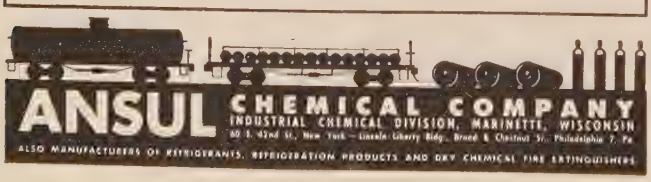

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and tapped. I will admit that you can talk a long while about that particular question.

ANON.: I would like to add to that. I was able to successfully prevent the surge of fan pumps by calculating the size of the suction that would go down from that tray in the rear of the paper machine and then have that pipe vertically down through an elbow directly into the pump, or not more than 3 in. from it. The calculation of the diameter of the drop leg of the pump was such that there could be inserted in it, concentrically located, an air release pipe about two thirds the diameter of the outside pipe. The accumulation of white water down at the elbow usually would exert some little pressure so that any air that became entrained and came down beyond the bottom of this head pipe would burst up into that pipe and smooth out the surges in the flow of the water.

MR. CRAWFORD: Back to our question of gas binding of stock pumps. Since there apparently is a natural aversion to the use of vertical pumps, centrifugal pumps, nevertheless the top entrance of a vertical pump seems to form a natural answer to the question of gas binding. What has the experience been with regard to the few pumps that you have made of that design?

MR. COLLINS: We have built quite a few pumps but not horizontal discharge and, for the benefit of the Gould pump men, we have experimented considerably not only in the field but in our own place, but where we learned the most was on what we call a quenching oil pump job which was a "hummer." We had a limited submergence, the oil was hot, it was a red oil that was used to quench or temper bolts and nuts which they put in a basket and lowered into this tank. Of course, it had to be recirculated and we had a pump on that job where the suction head and the whole thing could be revolved at will. It could be put in any position, within limitation of the bolting. It was originally a vertical discharge. We tried everything possible, including the vertical top horizontal. It made no difference at all and in all the attempts that we ever made we could detect no difference so long as the baffle and the throat were above the eye of the impeller. But if we had a bottom house on it which brought the throat of the baffle below the eye of the impeller, as you would have in a double suction pump, then that does make a difference. Looking at it theoretically or trying to analyze it, when you get air binding the air isn't up at the top but in the middle. What liquid there is has taken the outside course and clinches the air into a hard block at the eye of the impeller. As a result of an investigation we detected no difference between the top horizontal and the vertical, as far as the arrangement of the nozzle is concerned. I am waiting for someone to ask questions about the other end of the pump.

MR. AGRONIN: I think you misunderstood him. As I understood it he wanted to know what happens when you use a vertical suction rather than a horizontal discharge.

MR. COLLINS: The question is about the vertical top suction—I thought that I had covered that on the previous question in some way or another but. . . .

MR. Crawford: You had. You mentioned that you had made some and my question was what was the result with those that you had made. There seems to be an aversion on the part of the manufacturer against making a vertical pump because of mechanical difficulty and you did make some. How did they work?

MR. COLLINS: The result was very good. They were designed originally by us not for foamy stock at all and not for the same reason that the vertical top section condensate pump but it was designed originally to handle real heavy stock with minimum submergence. The design was born to take care of a job where we had to handle from two deckers—one deckering groundwood screening and the other one sulphite screening. It was impossible to build a deep chest. It was impossible to put the pump down due to high water conditions and they were put in there with a very low sub-

mergence. The deckers set over these chests. The only thing that ever happened on that job which wasn't 100% successful was due to the fact that the deckers were on top of an open chest with just a few channels across and once in awhile a bolt or a nut would drop off a decker and hit the pump. The mechanical department had quite a set-to about this. We had a conference with the manager of the mill and he listened to their hard luck story a good deal like a judge would listen in court. When they had the evidence all in he said "Gentlemen, if you will persist in pumping bolts and nuts go ahead and have your trouble." Otherwise it was very good.

MR. PACKARD: The second paper to be presented is entitled "Mill Engineer's Selection of the Paper Machine Drive, Part II," by Alfred N. Ball of the E. B. Eddy Co., Ltd., Hull, Que. I want to say right here and now that I appreciate Mr. Ball's taking on this second part since it was impossible for me to carry on, on account of being suddenly called to Washington.

MR. BALL: Many of you have read Mr. Packard's paper entitled "Mill Engineer's Selection of the Paper Machine Drive, Part I," given at the Fourth Engineering Conference in 1949. He also gave an Interim Report in October, 1950, at the TAPPI Metting held in Cincinnati, at which he advised of the steps that he had taken and intended to take to obtain a cross section of the experience of the industry and the various types of paper machine drives. Mr. Packard was later called to Washington to fill an important appointment for an indefinite length of time. After giving the matter considerable consideration, he decided that he would be so fully occupied with his new responsibility that he would be unable to give the preparation of this report the attention that it deserved. In order that the work would continue, he went to the trouble of paying me a personal visit and honored me by requesting that I take it over and with some misgivings I consented. My earnest hope is that the report will not suffer as a consequence.

"Mill Engineer's Selection of a Paper Machine Drive," by A. N. Ball (*Tappi* 35, No. 3: 112–116 (March, 1952)).

ANON.: I would like to ask Mr. Ball if he has had any experience with the newer type of mechanical drive that has been developed, whereby cork shock pads extend along the floor thereby limiting the space requirements and, eliminating belts. The draw is adjustable through vari-speeds. I don't know whether in your report you came across various drives of that type or not. If you did, I would be very much interested to know what the reaction was with regard to their installation.

MR. BALL: I have had no personal experience with the vari-speed types of drives. The only information that I obtained was from the questionnaire. I am afraid I can't answer the question.

ANON.: You mentioned in connection with cylinder machine drive that the helper be adjusted from the first press. What difference would there be if it were adjusted from the second press?

MR. BALL: I don't personally know that there would be any difference but I just know that they are. The manufacturers of that type of equipment do recommend that they be tied in with the first press. I presume that it would be all right except that you would have to tie in the first press as well as the helper drive.

ANON.: The comment I had pertains to section drives. One of the factors for consideration of the effect of drive, which I think is important in some instances, and we have found it particularly so, is the ability to control it in any one of several ways and the ability to instrument it and find out quickly what is going on between sections of the paper machine. One of those measurements which frequently is very helpful is the measurement of differential speed between sections of the paper machine. That is particularly true with

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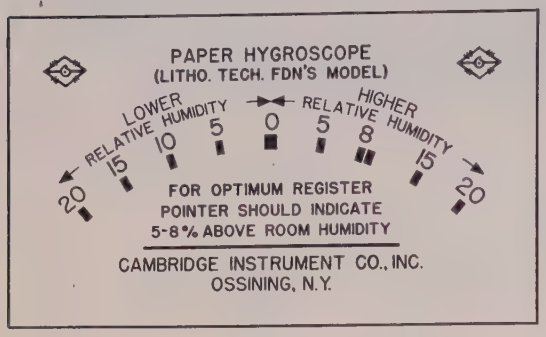

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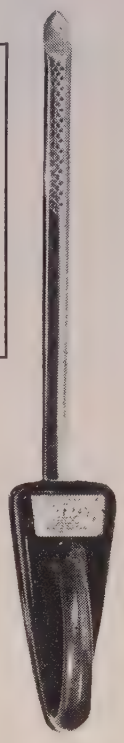

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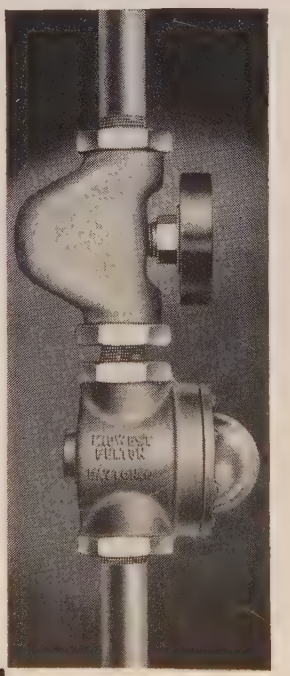

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the wet end. Quite frequently it appears as though the difficulty is due to the drive and instrumentation which can be attached and can be part of the equipment or can be connected quickly and you can tell without guessing whether or not there is any variation occurring at that place in the machine and look elsewhere for difficulty. Another measurement which is possible to make and used for control purposes which has been found on some very new machines is the measurement of tension. Actually the tension in the paper is measured and the current or the load is controlled by injecting a signal into the electric section of the drive to do the job of adjusting the draw automatically.

MR. CROCKER: You mentioned the need on calender drives for reversing drives. Is it necessary, in your estimation, to have this reversing drive where we have a modern calender with the quick life of pneumatic or hydraulic control which could separate the rolls?

MR. BALL: I am afraid I cannot answer that question. I am not familiar with the modern design of calender with the quick lift so I am unable to make any comment there.

ANON.: With reference to the gentleman's question regarding tieing in of one of the sectional drives, on the cylinder machine we have we tie in the fourth drier section. That is, we tie it in so that all of the others are a reference from that point. It is desirable to tie in some one section, otherwise in your draw controls you may find that you have worked all the way to one end of your adjustments and you will have to make a major change in all of your settings to get back to the middle. We do have one that has the fourth drier section tied in, which may answer the gentleman's question as to whether you can tie in the second press rather than the first press. Of course, the control is all the way from the first press through the cutters.

ANON.: Regarding remarks that I made concerning the helper drive—that is, in many of the board machines that are being renovated, the first thing they want to do is to throw out the old mechanical helper drive on the wet end only. The old drive is still left there, therefore, in that case you wouldn't have anything electrical to tie it into up around the driers because they would still be the old mechanical drive on the driers.

MR. PACKARD: We will now call this session to a close.

Engineering Research and Design

MR. PRINGLE: We are going to have in here for the next hour and a half the reports of the three committees from the Engineering Research and Machine Design Committee. The first committee that will report will be on the subject of "Centralized Control on Stock Systems." The second committee will be the Rubber Roll Committee and the third committee will be the one on the Methods of Quickly Estimating the Cost of Engineering Projects.

The first part of our discussion this afternoon is going to be presented by Bob Berger accompanied by slides.

MR. BERGER: As you may guess, these are illustrations of the modern stock system. The push button and the switch throwing age has made its debut in the paper industry. Throughout the industry the greatest of all changes in the past ten years has been the growing use of automatic centralized control of the various stock preparation processes. The newer mills are specifying automatic control as a matter of course. At this time I will turn the meeting over to L. A. Moore, our Chairman, who will present to you some of our ideas and will give you suggestions as to the mechanics in obtaining the information required.

MR. MOORE: I am sure by this time we have quite a variety of opinions on what you have just seen. Some of you might think that centralized stock is a "pipe dream" or something from a comic book. Others of you probably think it is possible. Others of you may think it is ideal on paper or a

power plant or oil refiner but certainly not in a paper or paperboard mill. Then others who realize its possibility will say when do I get it—what are we waiting for. It is the opinion of this committee that this project of centralized control of stock is not only possible but it is practical and economical. As a result it will be possible to have better control over the stock and we are all interested in a more economical product. The need of such systems is more urgent today than ever. Many of the "old-timers" are retiring To the old masters the new papermaking is an art. Those masters of the field who look at the stock and tell when it was ready for the machines are becoming fewer. Today young men are taking their places, many of which who do not realize the responsibility they have to their company, their fellow man, their community, or their country. Others are inexperienced in the old art and they have come to rely upon instruments, automatic controls, tests, and so forth, yet lack much of the needed equipment to give them all of the answers they need or the tests are not fast enough for present-day needs Operating personnel for the most part apparently like the idea of pushing a button and having a motor or air cylinder or some other device do the work for them. Today equipment is being pressed for peak productivity. Old equipment is being rebuilt, changes in design are being made, equipment is being added and today the equipment is producing more than ever dreamed of ten to fifteen years ago. With this increase in production the demand for quality to meet the competition is more precedent. In order to satisfy better quality control, better automatic equipment must be used to eliminate variations of the system and the human element. Now the question arises, what information and data are needed to promote such a program that will be of value to the group represented here today, and what plan should be used to accomplish it? This being primarily a report to our committee on Engineering Research Machine Design—on Feb. 1 a meeting was held in Chicago between Mr. Ware of Marathon, Mr. Berger, and myself outlining such a program. This program calls for the presentation of a paper at some future meeting of the engineering group after the data have been compiled, as outlined as follows: First, we plan to investigate the fields of jordan and refining plug control. Our intention on these following groups was that there is a lot of equipment that is available today that some of us know about, you know about some that we don't know about, and see if we could gather togethert his information of what is available and what can be expected of the equipment. One subject would consist of "regulation"—"level indication and control"—"screeners." I am sure a subject that is in demand today is some means of continuous checking of screeners for the average mill. Maybe some of you haven't—I notice a lot of us that don't have—if you run a test by the time it gets run you have a batch that needs to be changed. "Temperature and pressure"—"valving" such as Bob mentioned, motorized valves and indicators—"flow" then it was the plan of the committee that we divide the scope of this work among the various members of the committee and the collection of data was started by contacting various production men, equipment suppliers, and so forth. Comments as to whether the program that we have outlined, realizing that there is quite a bit of interest in the subject of centralized control, quite a few publications put out on it, special booklets put out by various suppliers, would be helpful to you would be appreciated so that the committee on the subject of centralized control can devote their interests more profitably. Do you people feel that there is a need for tabulation of information where you would compare, say consistency regulators, that would be together for making up your mind as to which ones to use and you would have the information that you need?

Mr. Sutherling: One of our big problems is control valves. Our stock dewaters very easily and we have tried butterfly valves and find that they hang up. I think an investigation on valves, a report on the type of valves that could be

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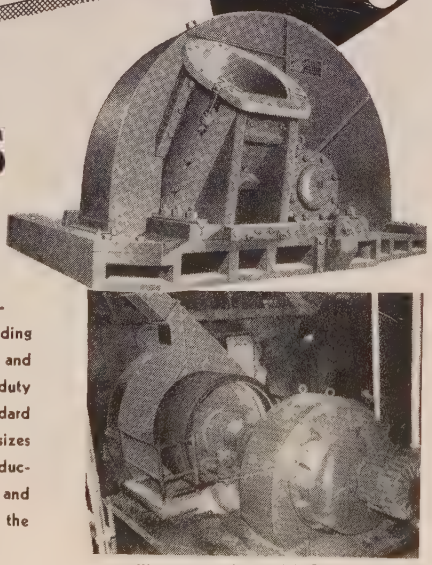

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used satisfactorily on different type stocks might be of some value to us. We have one other problem which I would like to mention, flow measure. At the present time we are using aero-type heaters but we have trouble as the stock dewaters quite readily.

ANON.: By the way the committee has started it certainly looks as if it is going to produce results which are going to be valuable to all of us. Your are asking for suggestions of where to go next and what to do about it. Examples of what those companies who have done the most in central control systems prefer, and along with that, the various variations that we can apply would be of help to our own problems. Of course, no committee can tell us how to prepare our own stock and how to centrally control it. We have to adopt that to our own use. However, a compilation of many existing facilities would help. You also mentioned the question of what we want in consistency regulators and other types of devices. We do need to know what is available in valves. We think we have solved our particular problem of valves but along with that there are the other components that go into a system, such as the various methods of measuring levels and using it for control, the various methods of plug control.

ANON.: As an example of what you are talking about, we have rigged up a "Rube Goldberg" recently that is quite interesting. We switched from beaters to a hydrapulper several years ago. We are now handling our stock in 3000-lb. batches. This cut down the number of men in our beater room tremendously and we were having some trouble in getting the chemicals added to our mixing chest properly. We called in our central instrument boys in our plant and they rigged up a beautiful gadget for us. They put diaphragm valves coming into the tank, liquid level bubble tubes in the tank, diaphragm valves going out. Then they rigged the whole thing up on a timer. This was all air operated except for the electrical timer. The foreman will set the liquid level controls in the various tanks for the proper formula for the particular paper going to that machine. Then when the operator has pumped over a batch of stock from the hydrapulper to the mixing chest he goes over and pulls the handle on this rather elaborate panel and the whole system takes over—the valves open to fill the tanks to the various levels, the liquid level control cuts them off. Then after they have all been filled the timer takes over the valves from the tank and adds the various chemicals allowing sufficient time for proper mixing in between. I think that is probably the type of thing you are looking for and we will be glad to give your committee the details of it. It shows what can be done. The thing is fully automatic and operating for a year and a half now without any trouble.

ANON.: I would like to add just one other factor which I think is close to the heart of all papermakers and that is the problem of measurement, instrumentation for weight control. I believe in the last few years there have come into the market types of calipers for continuous measurement of paper weights. Some people have had some experience with that and to get some information together for the benefit of this group—the limitations of the equipment—what weights can be applied on it, I think would be very desirable.

ANON.: Now this subject of centralized stock control, we realize, regardless of how enthusiastic a person might be on a subject, that it is not going to be a cure-all. The only thing we can do is to bring to the committee information of equipment which is available, the experience that various people have experienced, and from there, through our presenting various ideas, the various plant engineers can carry on for the benefit of their company. We also realize that no matter what you do that it can only be for several results. One is either better quality control or production or for economical reasons. We felt through this investigation that we would bring this information down to a very condensed form, a "Readers' Digest" form or something of that order. In order to bring this to a close, as we have others pressing for

time, I would like to take a vote on the outline that we proposed. How many think we are on the right track? How many feel that this that has been proposed by the general committee and our subcommittee is a worth-while project and that you would be interested in it?

"Measuring the Density of Rubber-Covered Paper Mill Rolls," by Ralph M. Leighton (*Tappi* 35, No. 7: 309–311 (July, 1952)).

MR. LYALL: This committee is working under the Chairmanship of Ken Brenner (Eastman Kodak) and they are considering not only rubber rolls but also methods of measuring the width of nips between resilient rolls.

MR. BRENNER: First I would like to call the members of our subcommittee up to the table here. Since it is a Round Table Discussion I think it would be appropriate for them to come up. Ralph Leighton (Stowe-Woodward), E. A. Crawford, E. A. Hodge (Pusey & Jones), and we have one other member of the committee, Phil Goldsmith (Pusey & Jones), who prefers to remain more or less incognito, I believe.

Our committee was set up primarily to study the question of water removal of presses. When we first thought of the thing it seemed very hard to segregate and find just where we would start. The first thing we tried to do was break it down to solvable problems. We will have to admit that these breakdowns are more or less tentative and we will have to vary them as we go along. The way we have done it is first to establish a method for measuring plasticity using a method where we can get reproducible results with an instrument that is available and, luckily, we were able to find an instrument on the market today which we could use. Secondly, the establishment of a method for measuring nips. Members of our committee have tried various methods, some are good and some are not, and that is the next step we are going to take. The third breakdown is determination of actual nip width and factors affecting it Work has been done by Dr. Reese and reported in the *Kenwood Bulletin* and seems to be very applicable to this problem. Work has also been done by F. A. Garrett in Montreal. It isn't concerned solely with press roll deflections but also takes into account the nip width and the water removal in the press section. The fourth and last and most difficult step is the actual procurement of data on the removal of water. I have a "hunch" that we are going to have to break down that particular phase because all of us know there are a tremendous number of variables affecting it. Under a subheading we should correlate the data we take on water removal and the data we have worked out on plasticity, diameter, etc.

MR. HODGE: Gentlemen, I appreciate very much the courtesy of your committee in allowing me to visit just to say a few words and they will be a very few words. This is a Plastometer that was developed for the paper industry. We kept the height to 4 in. in order that it would be handier in its application to a paper machine. The original Plastometer and one that has been used through the years is some 13 in. high but the principal point that I want to make is that the new Plastometer operates exactly on the same mechanical principal. It has a weight that is the same weight as the original one. It has a $^1/_8$-in. ball that is made of stainless steel and ground true. It has a slightly different mechanisim for raising and lowering the ball and also for raising and lowering the weight. The only two moving parts as far as controls are concerned is this knob for controlling the weight, and this knob for controlling the ball. The mechanism is shielded and protected better than the original Plastometer and we have a small pin which indicates the position of the weight, whether in an up position or a down position, and a level so that the instrument can be centered. Apart from that we have nothing by way of departure in mechanical principles. I simply brought the instrument here and I am pointing out these

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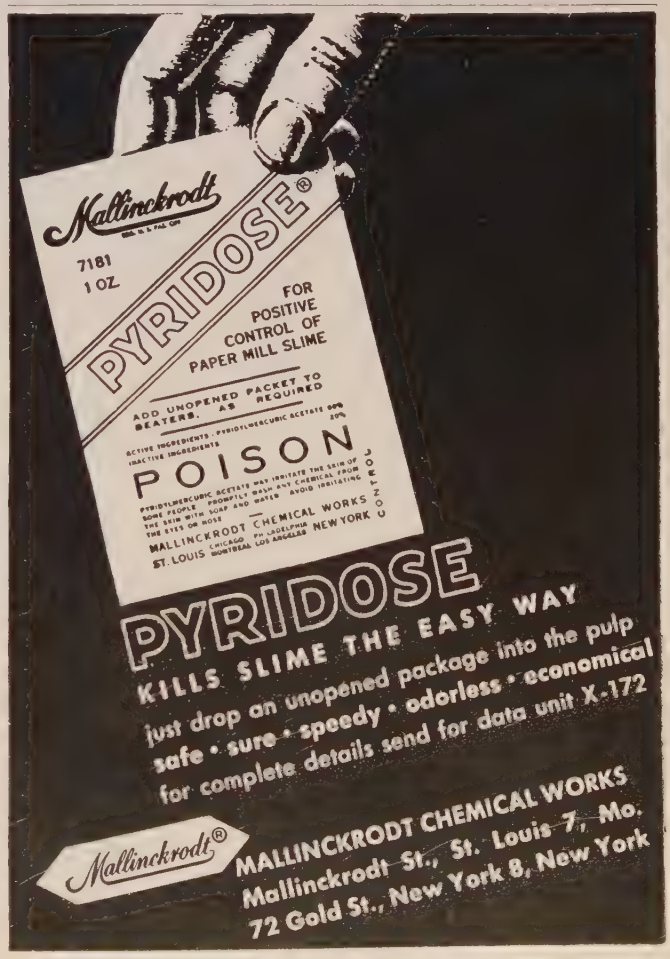

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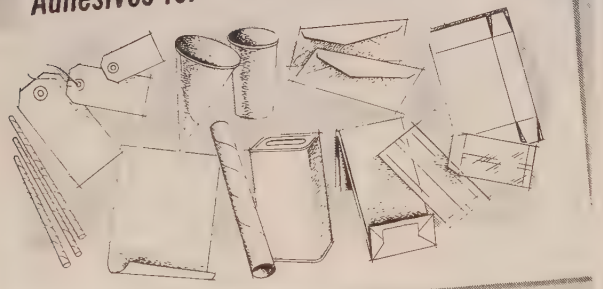

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differences because they reflect questions that have been asked from the very beginning.

MR. BRENNER: Thank you, Mr. Hodge. Before going on to a discussion of Mr. Leighton's paper or comments, I would like to point out that the tables he has included in his study and results of numerous tests indicate that there seems to be no real correlation between the Plastometer and some of the other instruments in use. For example, a rubber in the 95 to 100 Durometer range might show a difference of 13 between the hardnesses taken off the Vanderbilt chart or DuPont chart with the end of the minute reading of the Plastometer. In that hardness range of various compounds we find differences of from +21 down to +8½. Going on down through the various hardness ranges, for example in the 80 to 85 Durometer range, the difference varies from −3 up to +13 and so on down to the various ranges. Thus there is no fixed correlation at all, which is rather important, I think. It is the thing that makes it necessary for us to use the Plastometer in our studies of a press section.

ANON.: Does roll hardness affect the power requirement of the press section?

MR. BRENNER: We found the same thing with roll hardness of supercalenders, it does affect power. At the present time we are not planning on working on this subject because I think we have a rather large program outlined for just the press section although it is a logical thing to assume that we could extend the study in some future years to supercalenders. So far we have only talked about rubber compounds, but it could be extended at some future date, or it might be the subject of study by another committee—if Mr. Lyall is interested in it.

ANON.: What about Plastometer readings on suction rolls?

MR. LEIGHTON: If you attempt to measure the plasticity between the holes you want to make sure that you have the instrument centered so you don't get a false reading. The other thing, if the cover is very thin cover, a ½-in., you get reflection from the roll shell underneath and you will not get a true reading, so that anyone taking readings on suction rolls or thin covered rolls should be careful otherwise erroneous readings will result.

MR. BRENNER: Are there any other comments? If there are none—we are something in the same boat as our predecessors on this program inasmuch as we too are looking for helpful information, work that other people have done, particularly on the problem of measuring the nip width. We know that a number of methods have been used and we have tried a few of them. If anybody can volunteer some information on this subject we would be extremely interested in it. Another thing I might ask—do you gentlemen feel that we are approaching the subject in the right angle, trying to take some of these easier methods or easier subjects to work out and gradually building up a background so that we can attack the main problem? We will try to resolve our investigation into small parts. It will cover quite a few years that way but I think we will come out with the right answer. We would like to see some shortcuts if there are any but we, unfortunately, don't know of any at the present time. If there is no further discussion I would like to return the meeting to John Lyall.

MR. LYALL: The third committee that we have to receive a report from is on estimating costs of engineering projects. This committee is under the chairmanship of Harold Ingraham. We have with us Mr. Ewing who is helping him with this project. Mr. Hutchins who is another member of this committee is not here today.

MR. INGRAHAM: At the Fifth Engineering Conference of TAPPI in Cincinnati last year the Engineering Research and Machine Design Committee brought up for discussion a list of proposed projects for investigation and study by the committee during the ensuing year. Among the proposed subjects

was a suggestion that methods be established and indices published to assist in quickly estimating the cost of engineering projects. Those of you who are here will recall that there seemed to be considerable differences of opinion among those present as to the ability of the committee to work out something real.

MR. INGRAHAM: I will ask Mr. Ewing of the committee to give his report, following which we will be pleased to have your comments and suggestions.

MR. EWING: I am sure that we are all interested in concluding our business here as soon as possible, since the comments probably will be more important than this part of the program, I will read a "more or less" summary of what we did on this. As Mr. Ingraham has pointed out a program to provide ready means of estimating equipment costs for the paper industry is no small project. To be effective it should include a study of all or most of the common classes of equipment and it should provide a ready means of adjusting the data to economic changes.

MR. INGRAHAM: We think that there is a great deal of information in the hands of local mill personnel that could be translated into useful data if we only knew where it was. We believe it has to be an industry-wide enterprise and we would like to hear from any of you people who have any ideas. I would like to ask Mr. Ball if he would comment on this program.

MR. BALL: My only comment is that I think that any effort made would be very well worth while because I have definitely in mind that our own executives on occasion have asked for information and they don't want it next week, they want it that same afternoon. It is very, very difficult to give them anything approaching that unless you have some basic information to start with. We have initiated our own organization—we are a very old mill and have a good many machines and are trying to renovate gradually so we have a lot of problems of this nature that are constantly coming up. We have some rule-of-thumb methods we set up ourselves for conveyors and piping—for instance, in copper piping the length of pipe is tied in with the cost of copper at that particular time, multiply it by that constant, and arrive at an approximate figure. It does give you some indication of what a price is. Your prices in this country are a lot different from ours in Canada. If they are available you may be sure we will use them and work on a differential and multiply that by any rates that you might get. I hesitate to think that we would be able to give you much information—anything that we have would not be of very much value to you.

MR. INGRAHAM: What we are looking for is the expression from the group as to whether such information would be helpful if it was available.

MR. LYALL: The subject reminds me of an ad I once saw which said that by touching a dollar they can get a little closer to it. I think they have taken an almost impossible thing and made real progress with it. With reference to the rates of exchange there is an index that can be devised and Mr. Ingraham previously mentioned that they intend to work on that basis. In other words, the kind of installation and costs in comparison with the present-day costs in Canada and the United States can be worked out. There have been numerous occasions last year in which I would have given a great deal to have a few pages of such indices to work from. I think they have done a wonderful job.

MR. DREW: Frankly, I don't see what good anything like that is going to do us. I have done quite a bit of estimating at one time or another. To give your answers quick you have got to do practically nothing but estimating. You get all these data together and by the time you get it all it will be obsolete. You talk about savealls—after you got all that data collected someone may come along with a new saveall and just put everything you have collected on savealls obsolete. What estimating I have done and what I think I have learned about estimating is the procedure to be followed in

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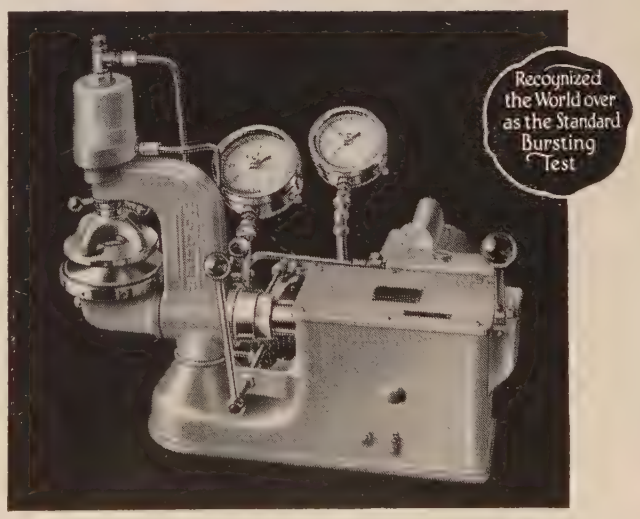

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making an estimate. If you do not have a set procedure to follow in making an estimate you can go so far wrong it is pitiful. It is my personal opinion that a set procedure for estimating that can be followed by engineers around the mill be made from time to time. I think such a procedure would be of much more benefit than to try to collate all of these data. To my way of thinking it is going to be obsolete by the time you get it. If you want to estimate prices you have two main classifications—you have the operation where you have to make estimations for changes in equipment. Your equipment that you buy is going to be designed not by your engineer but by your operating management. The operating management is going to have to decide on what equipment you are going to have to buy. When you get away from your operating you go into an entirely new project. There you are talking about a 10 to 20 million dollar kraft program. If you do not feel confident to estimate the thing yourself there are any number of reliable contractors who can give you an estimate on this who will be glad to write an estimate. Their estimate will probably be a lot closer than any estimate you might make yourself. The present-day contractors are especially valuable in estimating building costs. They deal with that day in and day out and have a lot of that information right at their fingertips.

Mr. Lyall: I think it would be a fine thing if they could produce, as they said last year, a crystal sphere which we could look into and estimate the price. I also agree that the obstacles are pretty insurmountable because there are so many different types of equipment, but I think that if an average figure can be calculated—this figure together with a breakdown can be modified by the mill personnel. That is, the admitted basis cost of material so that they can be multiplied for each mill modification and it would possibly be something that we can use. I think it is a wonderful undertaking to try to get something that will be useful to us in the mill for estimating. As engineers in the various paper mills who do our small estimating jobs we have our own unit costs and we also know how many feet of pipe, how many hours it takes, and we try to keep a fairly up-to-date price on those things. With the other odd jobs whatever you are putting in then it can be modified and could come closer.

Anon.: I agree and disagree with our friend across the way. I think that a lot of information that we might be able to get together would be worthless, however, I do think that by careful evaluation and careful selection of the subjects that are being investigated that much value can be gained. I have talked with a number of consultants and I happen to know from some that the only main thinking that they had to offer was the trigger quick answers that they could give. I remember at one time I got into a discussion about how much power we should have in our beater room that we just put in recently and we added up all the horsepower we had available and he said you have so many tons—you don't have enough horsepower—I won't tell you how we came out on it but that was just the comment. You mentioned that the operating personnel were the ones who dictated what to have. That may be true in some cases, however, a number of mills that I know of, where the engineering is an important factor and in our particular plant, I can assure you that there is not a piece of equipment bought in the plant without my personal signature. That is a plant policy. I happen to know some fellow engineers—I have been in their plant a number of times and that also is the policy there. I just feel that the engineer today is an important factor in the selection of equipment and some of these rules of some methods are helpful. Take for instance the jordan, we can find out easily how much it costs—it might be interesting to know how much it is going to cost to install. I have talked to a number of the suppliers and they say if you put it in a mill today it is going to cost so much a ton. I think those figures are interesting but you have to be careful in using them and not let that become the Bible because it is only a comparative guide.

Mr. Ingraham: I would like to hear an expression from someone as to the comment I made a short while ago as to whether published articles over periods of time would be representing the type of information that we want—the thought back of it being that perhaps some of your costs are in such form that in a short time they could be put together into a little story and perhaps made public. Then the subcommittee could take those costs, figures and methods of deriving same, and by applying the factor for present-day costs, could make them useful to someone who wanted to reproduce that particular installation. Does anyone care to comment along that line? Could we have a show of hands of those who think that the committee has a worth-while project—would such information be useful if it was available? John, I think perhaps you can take over.

Mr. Lyall: That concludes the report of all our committees.

Mill Design and Economic Aspects Panel Discussion

Mr. Clark: Some of the problems up for discussion here are the number and size of suction boxes on the wire. That is important—the size of your box and the size of your outlet—the amount of water than can be handled by the boxes satisfactorily and the control and the location of the controls are important—different types of control.

Anon.: This little experiment we ran is nothing unique. I think that probably every machine tender at sometime or another has played around with the idea of moving a suction box but recently we watched it a little more carefully and we have been bothered by what we call draw fractures—that is a wet sheet coming off of a couch and the necessity of running a fairly tight draw and the roll throwing out water at the discharge side of the box. In our experimenting we raised this box $1^1/_4$ in. backward up toward the top. We ran a lump breaker roll so we necessarily moved that $1^1/_4$ in. back up the wire and raised the dance roll between the couch and the first felt 2 in. We got away from our draw marks, which was the first thing, and we found we were able to ease off on the draw to the extent that we got better strength. We found we were able to reduce our long fiber by about 10%. In this particular sheet we were running about 35% and we were able to cut it down to 32%. The results are not too conclusive, we have only been at that about 1 month. One other interesting thing was that apparently we are getting a somewhat dryer sheet because even though we had no moisture test to show what we found we could cut our steam pressures about 2 lb. It may not be anything new but I thought it might start some discussion and maybe we could learn something too. We normally run about 16 and 20 in. on a sheet of raw stock for coating where we are running 1000 ft. and the basis weight is about 25 or 30 lb.

Mr. Clark: Mr. Perkins has witnessed some very interesting experiments on varying the width of suction boxes on the couch and suction press rolls. He also has had some experience recently on the very close control of vacuums. I would like him to describe the effect.

Mr. Perkins: As to the box width, there has been quite a bit of work in varying box widths on suction rolls and we wondered what would happen at higher speeds. We had a little machine made where we actually studied water removal without a sheet and felt and we were able to determine the amount of water removed without the addition of pressing. At higher speeds we found that we went up considerably higher in box width. Everything was held constant except the speed. We noticed a decrease in the vacuum but at the same time there was an increase in water removal—this at higher speeds now. At lower speeds, the curve was pretty flat, as I remember. As to the control of vacuum, actually this is one of Carl's innovations, we had a pressure controller with a vacuum breaker, just like our regular unit. This happened to be air controlled, and we were able to hold the

vacuum within $^1/_{10}$ in. where necessary. The valve, naturally, is only for a small portion of the air that you bleed in to control the vacuum so you have to have an auxiliary hand valve to put you in range when you want to pull the vacuum from 10 to 12 in. You can do it by adjusting the hand valve and then keeping the other end in perfect control and at the lower vacuum the same way. The control is very simple—it is just a pressure controller, air operated with a vacuum breaker—just like a pressure regulator. In this particular machine we were making toweling and we started out with a 12-in. box and couldn't get the sheet off the wire. By reducing almost 50%, we were able to do a much better job of drying the sheet and obtained much better results. I know that is contrary to some of the other peoples' experience but I think with our particular type of furnishes that it was necessary to do so. Perhaps with a long fiber with free stock it may not be the same thing.

MR. CLARK: I don't think your experience is contrary to other mills making light weight grades. I know a kraft mill in the South where they were making lightweight grades of kraft at about 1500 ft., and they reduced their box width in the couch from 10 down to 6. They found they had gone too far and they went back to 8 with the same pumps with improved results, that is moisture removal. If I remember the figures, you gain from 15 to 18% moisture removal. After all, what you are trying to do is get the moisture down to the point where it is safe to handle the sheet at the couch end of the press section and as long as it is safe it is not economical to go to more vacuum. Contrary to that, a mill recently replaced a total of 18 in. of box area width with a box 24 in. in width and gained almost 2% in moisture removal. This was on a very heavy weight board, 42 up to 90 lb. In other words, the box width in the suction roll apparently should be based not only on the machine speed but on the grade of paper or board being made.

MR. WARD: We have also reduced the width of the boxes in our couch to some extent. We actually started with a 10-in. box. The first reduction was down to 6 in. and we got some benefit from that. Later, wondering whether 6 in. was sufficient, we went to 4 in. on one machine and found that was just a little too much. In fact, I think it ran about 4 days before we had to go back to the 6-in. box, and now we probably will raise it in increments and see what results we will get going from 6 in. until we get back up to 10 in.

MR. CLARK: I would like to hear your experience on separators on flood boxes and water removal.

MR. WARD: We have separators on three machines and we recently experimented by increasing the capacity of separators on two of those units. In doing so we did find that by increasing the separator capacity we did drop the load on the vacuum pumps and apparently got some benefit in the sheet that we were forming on the wire. We have no test data to back that up but the papermakers claim that they did see some results from that particular experiment.

MR. CLARK: As I remember, these separators were some that you built and they were about three to four times the area as the pipe size of the outlet of the suction box.

MR. WARD: That is correct.

MR. CLARK: It took even more than that to get complete separation and best results.

MR. WARD: We have found it true so far. We still have some more trials to make on those machines, and we don't know what the complete answer is at this time.

MR. CLARK: There has been a great deal of work done with double boxes on couches. I think perhaps there has been more work done in Canada than in the United States. I know of four or five installations in this country and I think perhaps the most satisfactory installation, I don't know if there are representatives of those mills here or not, has been on machines that are making many grades—that is, from light weight papers up to heavy boards. The purpose of the double boxes has been to use only the narrow box, which is the first box, on the light weight grade. When you go on to heavy weight grades or boards the two boxes can be run in parallel. I saw one operating last week that was doing a very good job. From that standpoint it appears that the double box couch has some advantage on a machine where you have those variations. I have asked many questions in Canada of newsprint manufacturers as to whether or not the method that they have employed with the dual box couch has been helpful to them and usually you get an affirmative answer. When you check back you find that they have gone from a box width of 10 in. up to a double box couch of two 7-in. and have doubled their pump capacity. There is no direct relation between the results which they had before and after. One or two mills have experimented with that thing and have told us that they believe that the greatest benefit came with the additional area and the additional pump capacity that they added at the time. If there is any experience other than what I have given you I would like to hear about it. I believe that there is a newsprint manufacturer in this country that has done some experimenting on that also.

Where the water is very corrosive, the pumps will last much longer and you will get the effective vacuum for a much longer period of time. Also on any machine where the pH is under 5. The only other place where it has an advantage is where you have large quantities of water in excess of the economical limits of your vacuum pumps and also where the water temperature is so hot that you lose the suction in your pumps. I think Mr. Crowder has probably had some experience with high temperature in a couch.

MR. CROWDER: We have used high temperatures. I am not prepared to say now what the highest temperature is that we have used but, as I recall, it is somewhere in the neighborhood of 125 to 130° on the wire. Our stock is a little hot coming through the wire but we raised the temperature on the wire by injecting steam into the wire pit water. What we have been doing is taking steam right from our 150-lb. steam line and feeding it right into the water in the wire pit. In the summertime we have to be very careful because we have a river condition in Macon that is not exactly the best in the world and it is to our advantage to keep our effluents from the mill going back into the river at as cool a temperature as we can. During the summer we have been holding those temperatures down. As far as I know we have not put any steam in the wire pit during the last three months but as soon as the cool weather gets around we will start putting steam back into the wire pit again. We feel that we get better grained sheets by doing that. We found out that the pump on the separator was having to operate against an additional vacuum and just wouldn't handle the water away from the separator although we never found too much water in that separator as it is. We believe that we have gotten through the addition of these pumps a little dryer sheet going through the drier section. We have made a split on those pumps and tried to balance vacuums on the different blowers on the machine. Offhand I can't tell you the capacities that we have on the two couch rolls and on the press rolls. They are hooked up so that they can swap those things around and unless you look at them before you leave you don't know what you have done. We think we have plenty of vacuum in our plant right now for water removal—in fact we may have a little too much. We get good control. The thing we don't know and the thing we would like to know on our flat boxes is the amount of water that is being removed on each flat box. We don't know that—we made preparations at one time to put in a weir box that would fit down in the seal box so that we could measure each of these flat boxes and find out actually what we were doing on these flat boxes but we have never done it. It is a little problem to us to try to get it in and out on wire changes so we have bypassed getting that installation together at this time.

MR. CLARK: There is one large kraft board manufacturer in the country that is leading steam through from the con-

densing driers into the wire pit to obtain a higher temperature. They gain in two ways: they save live steam, there isn't enough bleed through to get the temperature they want, and they also get increased flow through the condensing driers. They are getting a better drying rate on the condensing driers as a result of that. I thought Macon Kraft was doing the same thing. There is simply one separator on the last set of condensing driers and at the top of that separator you blow through into the wire pit and the condensate which has accumulated on the condensing driers is then returned to the hot well in the boiler tank.

MR. GRIMNES: It seems to me that you have two difficulties there. One is that you more or less have to or you should keep the heat exchanger going summer and winter. That means in the summertime you do have different conditions than in the wintertime. The other thing is that it seems to me that whoever put in the heater for the air where you can take the traps off and just run the steam straight through you must overpipe those heaters tremendously to begin with because you don't get much heat out of the heater by just running the steam straight through.

MR. CLARK: These board machines in the South carry very high pressures in their driers and the steam on the condensing driers is still under some pressure. You have a lot of pressure left in them.

MR. GRIMNES: I found it very interesing to hear it because we have quite a bit of splashing of our condensate and it would be more advantageous to cool down the condensate. We have been wondering if there wasn't a simple way of doing it. In our case it never occurred to heat up some water.

MR. CLARK: I think it is true in your grade that you don't make any attempt to heat the white water.

MR. GRIMNES: We don't.

We have had some trouble with pinholes but as far as I know it has never been attributed to the vacuum system on the flat boxes. We do have a very bad condition in our flat boxes and we have been trying to find a way to get more vacuum. We can never get more than 2-in. vacuum on the boxes and one trouble undoubtedly is that we are taking too much water away from the first two boxes. They are running practically full. I think in our system we might be using some of our vacuum in the drop leg due to the fact we are taking too much water through the first one and it runs through the horizontal section. I am not sure that is true. It might actually be how much vacuum you could actually expect when you start getting a dry heat and you pump air.

MR. CLARK: Normally on your grade you receive from 3 to 4 in. of air, not more. I don't know what you get on cigarette paper. Too many mills get false readings on their flat boxes because they take their readings on the back-side coming off to the vacuum box. If they go around to the front side and connect a gage to the box to see how much vacuum they actually have in the box, many times the head will not lift it off the pin indicating that the box is too shallow or the outlet is too small. Many mills have replaced the first two or three of the old style small boxes with small outlets with large boxes and large outlets without changing the vacuum pumps to improve their water removal considerably. You may find that by changing the outlets on your suction boxes you can remove more water with the same pump. I know of a kraft board machine that originally had 14 in. of vacuum on their flat boxes, which is very high. It is running today with 7-in. vacuum on the flat boxes and they are making more board than they were originally. The difficulty was the outlet side, not the size of the pump. I will admit that for some reason or another on kraft papers the requirements of the vacuum pumps have gone up on the flat boxes and I don't understand exactly why that is. As the machine speeds go up you should carry higher vacuums to keep from throwing the water back in the sheet. I believe that is correct but you might ask some of the suction roll manufacturers if that isn't true. I know that factors on such a high-speed machines are from $1^1/_2$ cu. ft. per sq. in. to as high as 3, in other words, double. Where we used to consider 2 cu. ft. sufficient on grades such as you are making they are now using up to 4.

I just came from a mill recently where they were recording the vacuum on a couch and by that means we were able to check the weight variation in the sheet and trace it back to the source, which would be difficult in a vacuum gage. It was tied down definitely to something—it struck me that that could be a very important tool for a papermaker to use.

ANON.: Porosity is something that you can define as a large number of microscopic holes per square inch whereas pinholes can be discerned with your naked eye without a microscope. They are very undesirable in cigarette paper. I may add that the function of the microscopic holes in cigarette paper is to allow the air to get in behind the burning end and continue combustion while you are holding the cigarette in your hand.

ANON.: I would like to make a remark in reference to a vacuum gage showing variations in basis weight on your sheet. I have seen one mill where they have tried to control basis weight by taking readings on the vacuum on the suction couch. We all know that vacuum control is a factor that is influenced by a good many other variables and I was wondering if it ever was considered to try to control vacuum by varying the speed of the vacuum pump.

ANON.: Yes, I perhaps gave you the wrong impression.

ANON.: I mean when this particular mill was trying to control basis weight the reason that they failed was simply that if freeness or anything else changes then the vacuum changes, which may be something other than a weight change.

MR. MICHAELS: My interest in water removal is in the power it takes to turn the fourdrinier. During the past two years one of the committees has sponsored the accumulation of data on that subject. The data included the motor horsepower, vacuum measurements on the flat boxes, vacuum measurements on the couch, and with a little bit of arithmetic we tried to figure out what the answer was. One of the observations that were made was that the instrumentation on flat boxes is very poor, in general. To get measurements of vacuum head on the flat boxes we installed gages—most of them were located in the head or somewhere between there and the flat box and we tried to arrive at a value of coefficient of friction between the wire and the flat box top. Another observation was that the vacuum at the header was generally considerably higher than the vacuum at the flat box. The ratio varied as much as 10:1 with about 10 in. of header factor to about 1 in. of vacuum in the flat box. That was at the back side of the machine. On the front side of the machine there wasn't any vacuum. On one machine they were able to get paper from the fourdrinier to the press without any vacuum intake. The coefficient of friction on the flat box varied between 1, 2, and 3 for a new wire up to 14 for an old wire. Extrapolating from a running drive where a separate motor used to drive the couch where we knew the horsepower is adequate, indicated that most of the machines apparently have an average flat box factor somewhere between $1^1/_2$ and 2 in. On some kraft paper the vacuum has gone up as much as 6 in. on a flat box.

Hydraulics

MR. MACKENZIE: Those of you who attended the first symposium on pipe friction in Buffalo three years ago will remember that our dream at that time was a laboratory instrument that we could get some characteristics of stock from and a set of formulas from which we could calculate the pipe friction lost in any size or type of pipe. This paper indicates that we may be reaching our goal as far as the laboratory instrument is concerned.

"A Shear Criterion for the Hydraulic Behavior of Paper

Stocks in Pumps, Valves, and Flowmeters," by Victor P. Head (*Tappi* 35, No. 6: 260–266 (June, 1952)).

The next paper is an analysis of the Brecht and Heller data which have been going on at the University of Maine for the last year under a TAPPI grant. Mr. Durst who has been heading up this work will now read his paper.

"An Analysis of Data on Stock Flow in Pipes," by Richard A. Durst, Andrew J. Chase, and Lyle C. Jenness (to be published in *Tappi*).

As most of you know the Hydraulics Committee was set up three years ago to try to furnish some order of the chaos that existed in friction data. We have tried to maintain that as our only purpose. After our meeting in Baltimore three years ago we contacted all of the pump manufacturers in the United States manufacturing pumps for paper mills and asked them to submit to us their method of calculating pipe friction data. We came back with three sets of curves: the Allis-Chalmers curve, the so-called Cameron curves, and the Shartle curves. We also asked them for all the corrections that they used for determining pipe friction for different stocks. We had all their corrections and factors for stock and we had all their correction factors for pipe. After we analyzed them we found it possible for two pump manufacturers to be as much as 300% apart in their calculations for a pump for a certain type of stock of a certain consistency through a certain type of pipe.

Our next approach was a study of the literature. In the course of this study we obtained three items from Europe two of which were not of particular value to us but the work that Brecht and Heller did in 1935 looked promising and the Hydraulics Committee took over the job of translating it; it has never been translated completely. To give you an idea of what the job was we used about ten translators. The final finished report had something of the order of 65 double-spaced 8 by 11-in. sheets and something like 40 or 45 graphs. Those graphs were in the metric system and we transposed them over to English units. The translation was published in *Tappi* in a condensed form—it required so much space that we had to condense it. Meanwhile we had various members of the committee study the Brecht and Heller curves and also the piping system from which they were derived. Unfortunately, the general conclusion was that the pumping system that they use is open to question, particularly in respect to the location of the taps for monometer readings.

When we discussed this problem in Buffalo three years ago we thought perhaps we could come up with some sort of a laboratory instrument through which you could run stocks and come up with figures which could in turn be applied to a mathematical formula to give a friction factor for that particular stock. We started with an investigation of viscometers. We had two types at two different locations and we found that the standard instruments were of no value for this purpose. We concluded that we would have to do the same thing that had been done several times before, set up piping systems and make a whole series of measurements. However, some of us felt that before we went that far it might be of value to take the Brecht and Heller data and see if some mathematical relationships could be determined from it. The University of Maine agreed to take on the problem of analyzing the data and those of you who heard the paper this morning know where we are today. That is a summary to bring you up to date on what we have been doing. We heard of what Richard Head is doing and after listening to those two papers this morning I feel we are much closer to the solution of our problem than we were three years ago.

ANON.: I was very interested in the flat characteristic of the curves shown but there was one statement made which I had trouble reconciling with what has been done in the past and that is as far as industrial use of the friction curves, I think that all of us have been working on the steep part of the curve, the ascending part, rather than the part which levels off in the plot. I am just wondering what that means as far as interpretation. Are we thinking seriously of going up to higher velocities and higher consistencies of stock pumping which means larger pipe diameters or what is the interpretation of these data as far as practical use in pumping stock to pipelines?

MR. MACKENZIE: I am very glad that you brought up that point because it has been one that has been bothering me and we have to get information from operating men. What are the ideal or the practical velocities that we are pumping stock at now under normal conditions of different systems? That is going to be of value both to the boys at Maine and I know that it will be of value to Mr. Head who has not been in the paper business. Do you have any idea of the velocity you are now using; what range they are in for different size of pipes and different systems?

ANON.: I can't generalize. I think with most of us who have done some of our own pump and paper determinations they are usually found by trying to get the friction down to a minimum which means going to low velocities on the premise that that was the minimum power. Let us take 600 gal. per min. of 5% sulphite stock as the starting point. I don't know if I can give the exact determinations but I think velocities down around 3 or 4 ft. per sec. have been somewhat customary. I may be off one way or the other. I don't believe that velocity is characteristic of all pipe sizes. In the smaller flows that has been one of the questions in my mind as to what you do when you have smaller quantities. You may have some down as low as 200 or 300 gal. per min. If you use a 3-in. pipe there are no friction tables on it, at least I haven't seen any.

MR. HEAD: I would like to clarify that steepness of the line before we get too far on the range of operation. Actually the curves that are represented and the curves that are presented by the University of Maine pretty well span the same range of velocities and the same range of consistencies. As a matter of fact the Allis-Chalmers data went all the way up to 13 ft. per sec., all the way up to 12-in. pipe, and, on the basis of using viscosity of water for the Reynolds number, the Reynolds number goes up to a million. Steepness of the curve on the University of Maine presentation versus flatness of the curve on mine is entirely a matter of the theory under which you are operating and the type of equation to which you are trying to apply a coefficient. It is reasonable to assume that if in one method of presentation you have a slope of -2 for example, where you have a velocity appearing to the second power in the vertical ordinate and the velocity appearing to the first power in the horizontal ordinate then all in the world you have to do is say that because you have a slope of -2 automatically whatever the quantity is on the vertical ordinate the quantity on the horizontal ordinate squares will give you a single equation which doesn't even require curve presentation. If you then write such an equation and describe its coefficient you will come up with a flat line. As long as the line is flat you don't even need a better curve to find your data. In other words, that is the major difference in presentation. The slope is the result of the use of the University of Maine friction factor. The flat line is the result of the use of my shear criterion which, of course, I claim is the advantage of that type of theory.

ANON.: I believe we are a little at cross purposes—maybe I didn't make my point clear. I am talking about the conventional—I think TAPPI adapted the Allis-Chalmers friction curves for pulp. If you have your test curve here and your capacity curve here you have a curve that comes out, it does make a dip in the plot now. I have always been intrigued by getting out here at the higher velocity in terms of being able to pump more at the same head. The question I asked was are we getting out on this part of the curve—use

smaller pipe diameters—higher velocities and pump pulp at lower horsepower?

ANON.: It may be a very slight advantage but unless my memory fails me the Allis-Chalmers curves show that if you go from the peak of the curve down into the valley and then move straight up to a level which would correspond to the level of the peak and try to interpolate a difference in consistency between the line you are on and the next one you will find that the difference in consistency is only about 1/4% or less. In other words, when you are in the valley you can operate at perhaps 1/4% higher consistency and you will be right back at the value of friction corresponding to the peak.

ANON.: That dip is not very real in terms of practical application where it drops off.

I think that is true that if you were to take any of the data and pick out any particular point, 500 gal. per min. through 6-in. pipe at a certain consistency, then go to a pipe a couple of inches smaller in diameter and get your velocity up, your net horsepower will probably be higher in the smaller pipe.

ANON.: In the last couple of years there has been a fellow in Switzerland who has come up with a pump with which he has been using very small pipes. In other words, we have been recommending a 6 to 8-in. pipe, he has been working with a 4-in. pipe. We have been trying to analyze how he does it. He claims he can pump 6% through a 4-in. pipe. We haven't been able to do it. Everytime we figure it out our power goes up too high, our head goes up too high. I would like to say one thing on how you change your velocity. I think we mentioned before that oil pumps have a maximum head that you can develop economically. In most high head pumping jobs, which is what you run into with high consistency, you find a compromise between pipe size and maximum head. In other words, we have run 6 to 7% stocks in some lines at 6 to 7 ft. per min. because the line was short and it was such that our total head would not overload the pump. When the line gets long then we had to go to a larger size line in order to get down to the maximum head of the pump. I just had a condition like that for a European mill last week when they were trying to pump stock 2000 ft. We went through a whole series of calculations all the way down from 14 to 6-in. pipe. The whole thing ended up with trying to work the thing down to 180 ft. of head which is the maximum I could work for that pump. There is the question of power and maximum head availability of the pump.

MR. MACKENZIE: For the benefit of the research boys who are trying to get something out of the data available and are trying to develop something new for us, I have been carrying in the back of my head a velocity range of 2 to 8 ft. per sec. as a practical range. Does anyone have any comment on that? Do you think that is an acceptable range for practical purposes? These curves that you have seen do some peculiar things below 2 ft. and they do some equally peculiar things above 8 ft. per sec. If we can confine our work to the practical operating range and forget about whether or not we have uniform data beyond that practical range I think we will probably get somewhere faster. Is there anybody here who would like to comment on that 2 to 8 ft. per sec. range as being a practical range for us to work in?

ANON: I would like to ask a question on it. I had only the Allis-Chalmers data at my disposal and we have gone up to 13 ft. per sec. and the total points data which accounted for wide varieties of pipe size and a velocity range from a little bit more than 2 perhaps up to the 13 ft. per sec. was no more than ±15%. It seems that you just keep on going up to 12 ft. per sec. or thereabouts with practically no increase in head loss whatsoever compared to what you would have with pure water in the line. If you go from 8 to 12 ft. in a line you will double your head and if you go from 8 to 12 ft. you go up 10% with these high consistency stocks and that 10% seems to be peanuts. I don't know whether the other data are in agreement with the Allis-Chalmers in that respect.

ANON.: That is true for the Brecht and Heller—at the higher velocities they definitely go under water.

ANON.: For about a 4 1/2% stock you will fall below water friction at about 45 ft. per sec. That was established at the same time that I did these other tests.

ANON.: That bears out what Mr. Head found too.

MR. MACKENZIE: For practical operating men and the pump designers in the room, do you feel that 2 to 8 ft. per sec. is a range where we can go back in our studies and say as long as we have consistent data in that range we can forget the two outside ranges.

ANON.: I think maybe 10 ft. is a better range. I think you are going to go a little bit higher in velocity particularly if you know what you are doing. I think your tendency will be to take advantage of it. If we get any real data it will help us to go to higher velocities. I think we should shoot for maybe a little beyond what our customary range is today.

ANON.: I think it is related to the consistency and the type of stock. In other words, at a lower consistency and with the shorter and freer stock, such as groundwood, news, and so forth, if we could go to the higher velocities for the long fiber stock and for the heavier consistencies possibly toward a lower top limit.

MR. MACKENZIE: Would you like to suggest any particular ranges.

ANON.: I don't believe I have it in mind clearly enough to suggest anything—only a principle.

ANON.: In the next year or two maybe we will be able to give TAPPI a sort of standard and you fellows here now are going to decide in what range of velocities. Is there anybody here who would like to go over 10 ft. per sec.?

ANON.: I have found definitely that it is much better to hold your velocity up pretty well. For some reason or another, I can't explain it but I do know that even on 8 1/2% stock we are better off if we don't even get over 8-in. diameter pipe. I believe our friction loss will be less than it will if you use larger pipe. That is on sulphites.

ANON.: We don't like to use pipe that is small. As I interpret Mr. Head's comments it is not the high head loss in high velocities at least I hadn't thought it true. I think you should use as high a velocity as is practical within power limitations. As far as papermaking is concerned, we don't care how high the velocity is in a pipe if we don't waste too much power. We want to use as small a pipe as possible within practical limits of power.

MR. MACKENZIE: The thing we are trying to get here are opinions from the people who normally are working on this field as to just what would be a reasonable range to study in a theoretical or practical laboratory study. We want to know whether you want us to check data at 25 ft. per sec. or will you be satisfied with data that go up to 7 ft. per sec.

ANON.: There is one practical consideration that some people might be interested in and that is clogging and cleaning of pipe. If the pipe is too small it is necessary to clean the whole pipe whereas were the pipe larger they can poke a hole through it and clean it. The higher velocity you obtain the less density of the clog in the pipe.

ANON.: Of course, we haven't discussed gravity feed lines—all of our thinking has been on the basis of pump delivery lines. When we are thinking of our minimum velocity pump we also take into account lines down to the machine form the regulating box and from our headboxes to our machines.

MR. MACKENZIE: I think that is true and let us do what I have been trying to do for the last three years and confine this problem to pipe and to the flows that we normally find in pumping because that is the problem that was put up to us. I had a request from two people as to where there is information about the flow of stock over wiers. At this time I would like to take the flow of stock to pipe lines by pumping in the normal range of pumping. Can we agree that these boys that

are working in the laboratories or will work in the laboratories in the future on this particular problem will work on the range of 2 to 10 ft. per sec.?

ANON.: The power requirement, of course, will be directly proportional to the rate of flow if you have a given back pressure. The evidence of the Allis-Chalmers curve seems to indicate that a given stock means a given back pressure. I would think that you should start at something like 5% sulphide or some such thing as that and carry right on out until you begin to see a terrific upswing and perhaps 5% groundwood—keep carrying on out until you can see a terrific upswing because again it seems to me at high consistency especially there is no known evidence when the upswing is going to begin. The evidence of upswing is all in the extremely low consistency where it is comparable to water.

ANON.: If you could forget the range below 2 ft. per sec. and a range above 10 ft. per sec. would you say that the data which you obtain are reasonably uniform within those two limits?

ANON.: Below 2 ft. per sec. is definitely bad and below $1^1/_2$ to 2% consistency is also definitely bad. The transition from the kind of flow that you see in high consistency stocks back to something approaching that of water occurs below 2%.

ANON.: I think that is true.

ANON.: The upper limit seems to be the questionable one. Apparently we could keep going for quite a ways without getting away from the trend.

ANON.: In connection with the various sets of data, we indicated in one of our curves that the approximate difference in the friction factors that we plotted for the various data—I am afraid the agreement isn't too good, in that range of 2 to 8 ft. per sec. velocity, within various sets of data. Any consistent set of data has good agreement there but the data indicate that there are different levels. I wish we knew the answer why—perhaps due to physical setup of the equipment.

MR. MACKENZIE: We have to think about that sometime later on but the impression I got from your present paper of the variation that occurred from one collection of data to another is the thing I talked about a little while ago—criticism of the Brecht and Heller work. The difference may be characteristic of the system in which the work was done and if we ever do get into developing a new set of curves we will have to be extremely careful about the system. I suspect that the difference you get between three sets of data that you analyzed is the difference in the system because the pattern of your curves is the same.

Mr. Head's comment brings up another angle that I would like to have some decision on and that is on what range of consistency should we work. This question is again directed to the representative of the pump manufacturers here. Do you have any trouble in determining head loss where you were below 2% in the system or below $1^1/_2$%? What should be our limits—should we spend TAPPI's time and money on making studies below the 2% or what limit would you fellows set on that?

ANON.: Of course, this is only one opinion—we are interested in consistencies from 0.8% up to 8%.

MR. MACKENZIE: I know in our plant if we have a problem of stock below 2% we usually use the water data and we don't get into trouble. Does everybody feel that if we take 2% or below 2% water data that we are not too far off? What are the commercial limits of the pumps at the present time? Taking the problem of getting the stock through the pumps assuming that you can get it there by some means or another, what is the practical limit of the present pump?

ANON.: If you can get it to the pump the pump will pretty nearly always put it out regardless of what consistency is.

ANON.: I might add a little—we built a pump with a top vertical suction, in other words, we took a standard pump and turned it up on end with the shaft down and extended the shaft about a foot above the eye of the impeller and put one of our feeder vanes on the end. With that arrangement you could shovel in 17% stock and it would go through the pump and also through the pipe but you didn't dare plug the suction.

ANON.: In other words, if you cover the whole thing—if you dump a lot of stock in them it is quits.

ANON.: We pump through about 20 ft. of 4-in. pipe. That was a 4-in. discharge pump $11^1/_2$ in. diameter impeller around 80 to 90 ft. head.

MR. MACKENZIE: Can't we say with a normal approach flow to the pump a short run from the chest with a large inlet suction—would 8% be the top limit or would you say 10%? In other words, if you set up any kind of a testing system which we are leading up to, we will not want to get into any fancy feeder to the pump—we will want to work in a range where we can set up a pump with a good opening to the inlet of the pump—free-flow through it and not go beyond that limit. Is that 8 or 10%?

ANON.: Mr. Head, this morning you mentioned you had high hopes for the possibility of correlating the consistency with the step-by-step increase of the flat portion of that curve. Would you care to go into that a little bit further?

MR. HEAD: Very definitely. I think that one of the most important things that we are going to have to do is to add a measure of fiber length to a measure of consistency. Perhaps it would even be practical to say we should have equipment in the laboratory at least for measuring yield stress as such directly because fiber length and consistency can be correlated on an extremely empirical basis to predict what this yield stress will be. I hesitated to mention it this morning even though it is in the paper. It can be done with some success but I don't think that the equations in the paper should be particularly regarded as valid without a lot more evidence. Attempting to use such data as I had available to just pick guesses out of the air as to what the yield stress of the stock used in the Allis-Chalmers data may have been, it was a necessity for me to prepare those curves and I strongly feel that the fact that the sulphite and groundwood fell on two different curves is the fact that I didn't know the actual values of yield stress in either of those cases. You must measure the yield stress for awhile anyway.

ANON.: Why is it you use a brush rotor in your apparatus rather than the plain drum?

ANON.: I felt that there might be a tendency toward water separation and it seems quite evident that a practically stationary plug would exist in the shear tester. Therefore, I must develop it at a radius which I could measure so that the wire brush idea was to snag the fibers and pull them around and cause them to shear the way they would in a true shear picture rather than just at a surface where a decided layer of water alone might exist.

MR. MACKENZIE: I think this would be a good time for me to bring up something I intended to bring up this morning. For 20 years I have been looking for a good quick fiber length test because of the interference of fiber lengths in slowness testing.

We tried almost everything that we could put on a production basis. For two or three years we operated with a projection type method of measuring fiber lengths having our shift testers do it. They got so tired of counting the fibers we had to give it up. When I read Mr. Head's paper when it was submitted a couple of months ago this fiber length test hit me right between the eyes. I turned the problem over to our laboratory and I have a preliminary report here from them. I think I would like to read it—it isn't too long but I think it will answer a lot of the questions on fiber lengths and how accurate Mr. Head's work was.

Steam and Power

MR. SIBLER: I want to introduce our speakers as they get on the platform. We have selected two subjects: one on steam piping which should be a rather interesting subject particularly

in this section of the country where more high-pressure steam plants are used than in the older mills in the northern part. The other subject will be on gas turbine in paper mills, which is looking into the future. I want to introduce Mr. Kerbey, Executive Vice-President of Midwest Piping & Supply Co. who has been instrumental in developing modern high-pressure piping and fittings. I am sure you will find his talk very interesting and timely.

KERBEY: Thank you, Mr. Sibler. Gentlemen of TAPPI it is certainly a real personal pleasure to appear before you. It happens to be my first visit to Savannah and it affords me an opportunity to extend my respects to one of your paper industries, the Southern Paper Board Co., whose work we did within the last several years. In a review of papermaking history one is impressed by the dramatic changes that have transformed the industry in relatively recent time. Three centuries and a half ago the manufacture of paper was a laborious hand process, tedious, expensive, and highly inefficient. Today's modern papermaking is of tremendous capacity and its efficiency is evidenced in the remarkable low cost of its product.

"High-Temperature Pressure Piping," by Eric A. Kerbey (*Tappi* 35, No. 5: 203–208 (May, 1952)).

MR. KERBEY: The nondestructive testing that we have been using is satisfactory up to a point. We have every reason to believe that it can be developed to an extent where it can be done economically on perhaps every foot of material that goes into the high-pressure system. The prospects are good. I mentioned cobalt 60. For those who might not be familiar with this cobalt product it is produced at the Oak Ridge Laboratory and for all intensive purposes it takes the place of radium in radiographic examinations. It has a limited life but at the same time is very satisfactory.

MR. SIBLER: Maybe we can induce Mr. Kerbey to let us have some of his methods when they are fully developed for our TAPPI Data Sheets. We have been using their method in our company quite successfully for the last two years and we certainly have intricate problems and you all will have them too.

MR. KERBEY: The method is fully developed and it is now a matter of putting it in published form. It does a reasonably close job—a good job—in a relatively short time. Of course, as I pointed out in my earlier talk, it is more or less turning a crank after you have analyzed your problem.

MR. SIBLER: The next speaker is Mr. Bloomquist of General Electric and he will talk about the possible application of gas turbines in paper mills.

MR. BLOOMQUIST: Mr. Chairman and Members of TAPPI—in a talk like this you can only hit the high spots. If you are interested perhaps we can get together afterwards or you might be interested in reading the complete article which will be printed in *Tappi*.

"Combustion Gas Turbine Applications in the Paper Mill," by W. B. Wilson and W. C. Bloomquist (*Tappi* 35, No. 3: 81–87 (March, 1952)).

MR. SIBLER: I am sure many of you are interested in new developments like the gas turbine and maybe you would like to be clarified a little bit more.

Question from the audience not heard.

MR. BLOOMQUIST: That first locomotive made quite a bit of noise and the gas turbines do make some noise there is no question about that. However, Friday, just before I came down here, I heard the new 5000 kilowatt on test and I was amazed at how quiet it was. They have a baffling arrangement that goes into the intake which does a wonderful job in keeping the noise down.

ANON.: Another thing I wanted to ask you about: the locomotive had a reputation for poor part load economy. Is anything being done about that on a stationary application?

MR. BLOOMQUIST: Yes. Remember now that the simple cycle, which was the first slide that I showed that applies to locomotives and the Oklahoma Gas and Electric, is a single shaft machine so the efficiency is poor, very definitely poor, particularly when you realize that two thirds of the power goes into air compression. For your applications I wouldn't expect that you would use that kind of a unit for power generation but when you use it for exhaust heat recovery then it is an entirely different thing because you are not interested in what the unit efficiency is, you are interested in what your over-all efficiency is. Take that second one, those 30 odd units that are going to the pipeline industry, those have two turbines on it—one compressor but two turbines and they have a pretty good efficiency, $23^1/_2\%$. We have gone still further with the utility unit. We have introduced inner-cooling, two turbines, two compressions, and regenerators and that is 26% and the part load efficiency of those last two units hold up pretty good but not as good as the steam turbines.

ANON.: This matter of coal against oil—up North coal runs say 40¢ a million B.t.u. and oil runs 80¢ a million B.t.u. You did touch on the coal proposition but as I understood it you were referring to producer gas. Isn't it true that if you put in a producer plant that you would have complications and other capital costs that would pull that down. I wondered what you think about the application that is being used on the Olive turbine for the locomotives where they are going to try to separate out the fly ash and burn the pulverized coal directly?

MR. BLOOMQUIST: That is one of the two attacks being taken. The other group with this bituminous coal research organization are trying to use pulverized coal directly into a turbine. There the problem, of course, is to get rid of those fine particles so it doesn't wear away your blades and they are coming along very well I understand that unit will be in operation, on test, about January, but how it is going to come out—whether it is the producer gas or that one I don't know but certainly there is going to be a coal one.

ANON.: The thing that I think would concern anybody immediately is that according to the press the oil shortage in the next war, if we have one, is going to be much more acute. They are talking about using two thirds of all the oil for military purposes. If you are not in a natural gas region I wonder where you would be with a gas turbine?

MR. BLOOMQUIST: You will have to look in a crystal ball.

QUESTION: What about part load difficulties?

MR. BLOOMQUIST: I don't know about any difficulties but the economy is poor. I would visualize that the gas turbine for the paper industry would be like a noncondensing machine—back pressure machine—a base load machine. Incidentally, I would like to have you think of the gas and steam turbine this way—the noncondensing steam turbine-electric powers the by-product. In a gas turbine exhaust heat or steam or whatever you want is the by-product—not power. Heat is the by-product there.

MR. SIBLER: If there are no more questions, I would like to make one closing remark. It is not very easy to put on a program like this—the program is not put on by the committee or for the committee—it is put on for the members of TAPPI that come to these meetings. The only way we can put on a program that will satisfy you, that you will find interesting, is if you would let us know what you want us to present. We are always open to suggestions.

Electrical Engineering

MR. SORENSON: Last year in Cincinnati Mr. Foster read a paper on motor applications. Since that time we have asked several mill engineers and manufacturers to review the paper and give us their suggestions for additions and modifications in another report. At the present time we have quite a number of these and during the coming year we will incorporate them into this paper, change it, or add to it, so that at the end

of this year we hope to have it completed and published in *Tappi*.

For our requirements of fourdrinier sections, Mr. Mikelson of General Electric Co. has certainly done a fine job on this. He has also developed a procedure for taking the data and correlating the results.

Mr. Mikelson: Fellow Members of TAPPI, last year in Cincinnati a preliminary report was presented on power requirements for fourdriniers based on the analysis of data obtained on four machines. During the past year, we have accumulated data on seven more so that the total is now eleven. The results of the additional machines check fairly well with the results obtained on the first machine. The figure which has been established permits determining the power requirement of a fourdrinier section more accurately than has been possible in the past using a constant generally accepted by TAPPI. There were several miscellaneous observations made during this investigation. One was that it was a little difficult to get readings on the flat boxes. The instrumentation at the present time seems to be using vacuum gages at the header and sometimes on the riser through the flat box and not too often on the flat boxes themselves. Yesterday, at the session on water removal, it was indicated that practice is leaning more and more toward putting vacuum gages on flat boxes and it is hoped that machinery builders in the future will make an effort to have the vacuum gages located at a point where more accurate readings can be obtained at vacuum at the flat box.

"Fourdrinier Suction Load Requirements" by W. Mikelson (*Tappi* 35, No. 8: 337–342 (Aug., 1952)).

These tests were made on bond, kraft, and newsprint machines—from 200 to about 1500 f.p.m. and the weight carried from about 20 to over 100 lb. for 3000 sq. ft.

Question: Was there any relation at all between the wire life and the high friction value on the tests received?

Mr. Mikelson: There was a relation between wire life and friction. The coefficient of friction seemed to increase with wire age and maximum variation was about 2:1 for a new wire to an old wire. In some cases the variation was about 25%. The figure varied from 100% increase to 25% increase and that is shown on Fig. 6. This slide shows a variation of wire age with friction, for instance, machine B starting at the beginning, the coefficient of friction was about that much as the wire age of the coefficient of friction increased at that point. The smallest increase is shown on that curve and the biggest increase is probably shown on that curve—that is about a 2:1 increase in coefficient of friction as the wire aged from new to old.

Anon.: That is not exactly what I was asking—I was thinking of wire life rather than wire age. Is the wire life shorter if the friction value that recedes there was higher?

Mr. Mikelson: I don't think we have enough data to make any positive statement on that. I think that about all we can say is that it seems reasonable that it should but we don't have any confirming data.

Anon.: The power data that you have given seem to indicate that the TAPPI constants are very far out of line and I am wondering how you can account for the fact that if they are so far out of line that they have been applied for many years and in but few cases have been found lacking as to the actual power requirements. There are few cases where we have found that couches selected, motor selected in line with those constants have been adequate to do the job. I wonder how you account for that?

Mr. Mikelson: The TAPPI constant as it exists at the present time is adequate for probably 90% of the cases which means that if you put a motor on according to the TAPPI constant it will run the fourdrinier section. In the remaining cases, particularly on newer machines the TAPPI constant is not large enough to take care of the power which will be needed. Using a new constant will merely make it possible, in some cases, to tailor the motor more closely to the actual requirements of the fourdrinier section rather than just picking a motor that is big enough to catch all.

Anon.: In the practical application of the formula that you have derived it would necessitate knowing the expected vacuum. You have given a value you consider adequate for machines on free stock and slow stock, however, you make no mention of the fact that the vacuum would certainly depend on the number of boxes. In other words, if you tried to run the machine with ten boxes you would go to a lower vacuum than if you would run it with eight or six. Then the number that you give as being the average vacuum applies to how much vacuum length or area. You gave a figure of 4 or 5 in.—does that apply to four, six, eight, or ten boxes?

Mr. Mikelson: The figure that I gave was 2 to 3 for free stock and 4 or 5 in. for slow stock.

Anon.: With what length.

Mr. Mikelson: There wasn't any length specified in that data. The responsibility for providing flat box vacuum figures rests with the ultimate user, in other words, if the ultimate user does not know now, over a period of time he will be able to provide information on what the expected vacuum is to be on his machine. All we do is take the figure that he gives us for what vacuum he expects to have at the flat boxes and try to convert that into a horsepower figure for motor size. We don't try to specify what vacuum the papermaker is to use in making the paper but we suggest, based on past experience, if that information is lacking that an approximate figure can be used to arrive at a figure.

Anon.: In your analysis did you find that that figure was lacking in practically all cases? You were surprised to find the vacuum where it was.

Mr. Mikelson: The mills were surprised to find that it was as low as it was. It was lacking in most cases and those cases where we had it we did it by putting gages on the flat boxes themselves. In some cases the gages were already on the flat boxes and in some, as you noticed on the chart, the only vacuum readings obtained were the vacuum readings on the riser to the flat boxes. In some cases it was back further than that—back at the header.

Anon.: As one who has occasion to apply motors to couch sections of paper machines, I am just wondering how we can put this formula into effect or make it workable if the knowledge is not available as to the vacuum requirements on typical machines?

Mr. Mikelson: You can do two things, first of all by using the formula and the chart (Fig. 2). I presume now that you don't know anything about what vacuum to expect.

Anon.: I am assuming that I am a motor manufacturer and I am being asked to supply a motor to a couch section of a fourdrinier machine and I am looking to the customer now to tell me what he wants.

Mr. Mikelson: If the customer tells us that the stock is free we work it out in the region of 2 to 3 in. of vacuum and that gives us a constant which closely approximates the constants which have been used to date. If he uses the largest length he gets up near this one figure—if he uses the smallest length, depending on the number of boxes and the width of the box if that figure is low then you get a figure down here near 75.

Anon.: What would you consider a free stock?

Mr. Mikelson: That is up to the papermaker. We in the electrical industry do not attempt to determine whether the stock is slow or free.

Anon.: I am trying to get to the practical end of this. I really would like to get a practical way that that formula can be used.

Mr. Mikelson: We have used it in a practical way and where it has been of the greatest use so far is on kraft paper, where we have been told by the manufacturer that the stock is expected to be slow and that they expect to have an average

vacuum at the flat boxes of approximately so many inches. It turns out that the vacuum is up here in the 4 or 5 in. region and the curve has indicated that the TAPPI constants are inadequate. We have been able to avoid under-motoring a machine by that simple procedure.

ANON.: We have had occasion to do the same thing and we have applied the TAPPI constants in all cases and in no case have we found that we have been inadequate in motor sizes. Therefore, there must be some average measurement that comes out—that equalizes itself—I don't know what it can be.

MR. MIKELSON: We have had cases of under-motoring using the standard TAPPI figure and then adding a little gravy on top of that—picking the next size larger and the motor has not been large enough to drive the fourdrinier sections.

MR. FOSTER: It may seem peculiar to some of you to find on the program of this association a paper on such a prosaic subject as insulated wires and cables. On the other hand, the work that Mr. Mortenson has done with his committee indicated a widespread interest in insulated wires and cables as applied to your industry and also has indicated a certain amount of trouble that you have had in the past that you would like to anticipate in the future. While this paper is confined to the types of insulation there is another part of the subject that sometime you must consider and a part that you may not enjoy and that is the use of aluminum as conductors. That part is not discussed here but it is a subject that, undoubtedly, in the next few months many of you will have to consider because of the shortage of copper. As a result of chemical research and technological developments during and subsequent to World War II much information has become available to electrical engineers concerned with the distribution of electrical energy as well as those interested in communications. A new field of electrical insulating materials has offered a wide range of electrical, chemical, and physical properties consistent with longer service life expectancy than thought possible only a decade ago.

"Properties of Synthetic Rubbers and Thermoplastics as Insulation for Electric Cables," by E. W. Davis (to be published in *Tappi*).

Steam and Power Discussion Session

MR. SIBLER: Our first subject is on fly ash and sand from bark burning units and Mr. Bollinger of West Virginia Pulp & Paper Co., Charleston plant, will start off with the discussion.

MR. BOLLINGER: Cinder and fly ash collectors form an intricate part of most present-day boiler installations.

The various types of collectors available and now on the market are settling chambers, impingement or baffle collectors, electrostatic collectors, and centrifugal collectors such as cyclone, fan, and tubular collectors.

In cinder separation, the condition under which a collector must operate varies from installation to installation and in day-to-day operation. The fly ash and cinder is a major variant. It is not a homogeneous or uniform material. Its physical and chemical properties vary widely, depending upon such factors as the type of fuel burned, type of furnace, furnace operations, and preparations of fuel.

Since a great deal of data have been presented on cinder collection when burning coal under a boiler, we feel that during this discussion we should not spend too much time on this subject since we have a cinder collection problem almost confined to our industry; namely, cinder collection when burning bark under a boiler. To date, very little information has been published on this subject, and only a few complete tests have been run on a bark-burning unit collector.

The continuing high costs of coal, oil, and natural gas have made most pulp and paper mills seek greater efficiency in their bark-burning units and are forcing the burning equipment and boiler manufacturers to improve burning methods and furnace designs for use in burning bark. After all, we in the pulp and paper industry would like to obtain all of our steam from by-products.

Bark, today, is no longer looked upon as a refuse to be disposed of, but is considered and designed in the layout of a mill to supply a portion of the basic steam supply.

Methods of firing bark have much to do with the amount of cinder or fly ash leaving the boiler. The same holds true for furnace design and methods of preparing bark for burning. When you talk about cinder collection on a bark-burning unit you must talk about burning equipment design.

With this in mind, I have listed some of the basic designs on burning bark and collector units which are:

Methods of Firing:

(a) Dutch oven
(b) Stationary grates
(c) Spreader stoker with traveling grates

Methods of Preparing Bark for Firing:

(a) As bark comes from the barking drums
(b) Bark through a crusher to give a more uniform size for firing
(c) Predrying or pressing bark to remove excess moisture before firing

Furnace Design: The furnace should have sufficient volume and height with low gas velocities to allow the bark to burn as completely as possible before it leaves the boiler. Where sand is a problem, a single-pass boiler is sometimes considered advisable due to the possibility of erosion at the passes of a baffled boiler.

Air Supply: There seems to be some varied difference of opinion on the distribution of air to efficiently burn bark on a spreader stoker. It is the opinion of some that bark should be burned in suspension, and the overfire air and cinder returns be designed to enter the furnace to give the maximum turbulent effect in the rear of the furnace. It is felt by some that the greater percentage of air should be in the overfire air and cinder return system air. Some feel as much as 80% overfire and 20% undergrate air is an efficient design which will result in more complete burning of the bark, therefore resulting in less carry-over of cinders. Since bark in this area contains 40 to 60% moisture, it is felt that the higher the temperature of the overfire air, the better and faster combustion will take place.

Collector: A collector should be designed with maximum capacity and efficiency in order to collect the cinders.

Bark cinders should not be stored in collector hoppers. The cinders are still burning when they enter the collector and if allowed to build up in the hopper will fuse into a solid lump which will clog the hopper outlet.

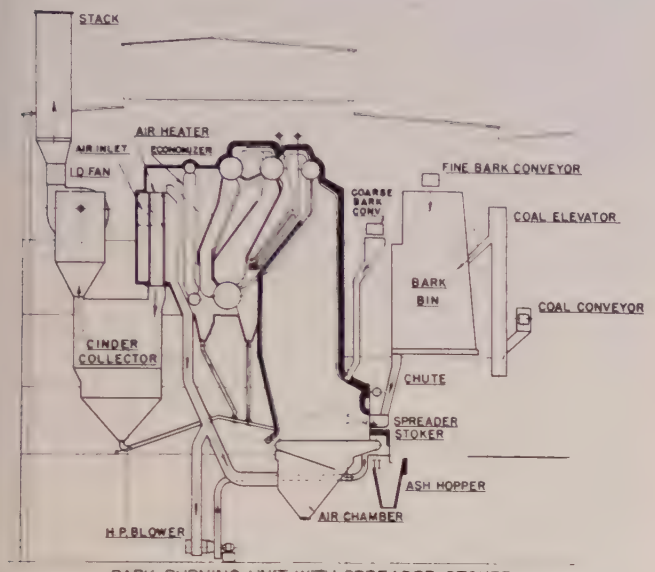
Low CO_2 in the boiler gas, leaks in the hopper, or air from a plugged or overloaded reinjection system can create enough fire in the hopper to melt out the hopper steel.

Sand which is carried over with the cinders definitely causes erosion. The greater portion of collectors that have been in service for the past ten years have been of the low draft type. Inspection of these shows a minimum of erosion. However, during the past few years, cyclone collectors have been installed on bark-burning units in the Southeast. The question is: what will be the maintenance cost due to sand erosion?

Reinjection Systems: Any reinjection system removing bark cinders from collectors or boiler hoppers should have much greater capacity than if figured for coal cinders in order to keep the hopper clear under heavy loads.

There seems to be a varied difference of opinion as to the location in the furnace of the reinjection system. Most designers enter the reinjection in the rear of the furnace, which brings up the question as to why they place it at this particular location. Is there any reason the reinjection cannot be installed in the side of front walls? Would this tend to increase turbulence in the furnace and more completely burn the cinder before it reaches the boiler tubes? Also, where should the reinjection nozzles be located in reference

to the feeders and overfire air nozzles? Reinjection usually creates arguments between stoker manufacturers and collector manufacturers as both look at the problem from a different point of view. One of the most outstanding problems in the Southeast is sand in the bark and sand carried along with the bark; also, the recirculation of sand through the boiler when an efficient collector is installed. This sand problem has caused high maintenance costs in the erosion of boiler tubes, ducts, and collectors in some bark-burning units.



BARK BURNING UNIT WITH SPREADER STOKER

Fig. 1

In order to illustrate this problem, the following is a brief résumé of the erosion problems and some of the changes made to lessen the erosion on a four-drum (three-pass) Stirling boiler with a spreader stoker and a low draft cinder catcher, designed to burn bark. This unit was installed in one of our mills in early 1946. In order for you to follow the résumé, a cross section of the boiler is shown in Fig. 1. (1) When the boiler was put into operation, it was found that the cinder return system was underdesigned. Additional return lines were added with a redesign of the air nozzles to obtain a better injector effect. (2) In May, 1947, the economizer tubes started to fail due to sand erosion. The location of these failures was directly in line with the gases as they left the third pass of the boiler. During Aug., 1947, it was necessary to renew two rows of economizer tubes. Shields were installed on the first row of new tubes and the length of the third pass baffle shortened about 2 ft. (3) In 1948, there was definite evidence of erosion on the boiler tubes in the third pass and the ends of the superheater tubes. The lengths of the first, second, and third pass baffles were reduced 2 ft. (4) The wearing plates installed on the induced draft fan blades and casing were renewed in 1947 and 1950. (5) In late 1948, the cinder returns from the boiler hoppers were removed from the furnace and transported to a power boiler furnace by means of a separate air supply. This reduced the recirculation of cinders and sand in the boiler and increased the air available for the cinder catcher returns. The boiler tubes started to change from a highly polished color to a gray color. It was estimated that this system deposited anywhere from 500 to 1500 cu. ft. of sand per 24-hr. day in the power boiler furnace. (6) After consulting with the boiler, stoker, and cinder catcher manufacturers, and with various tests made at the mill, a system was designed and installed in 1950 to classify the returns from the boiler hoppers before returning them to the furnace. (See Fig. 2.) This required an additional high-pressure fan. Briefly, this system is as follows: The returns from the boiler hoppers pass over a No. 16 mesh stainless steel screen set at a 25° angle. This angle was determined in the field by setting up a test unit so the angle could be varied. Samples were taken from the returns and passed over this screen at various angles and analyzed to determine the amount of sand and combustible material passing over and through the screen. It was determined that the 25° angle gave best separation. The classified bark particles are fed back into the rear of the furnace and the sand is dumped into a container in the basement. This system has removed around 300 to 600 cu. ft. of sand in a 24-hr. day. (7) In early 1951, failures started in the third-pass boiler tubes and the inlet ends of the air heater tubes. It was necessary to plug the worn boiler tubes as they could not be reached for welding. Ferrules were inserted in the inlet end of the air heater tubes. (8) In 1951, all manufacturers were brought together and given a plan with recommendations for reducing the sand erosion and increasing the burning rate of the bark in the furnace. It is hoped that design details and materials can be worked out so that installations and changes can be made in 1952.

One mill found that after a flume was installed for conveying wood, it reduced the concentration of sand in their bark-burning units as much as 50 to 60%. In some cases the wood is washed before it enters the barking drum, and others screen it after it has passed the bark crusher. All of these tend to reduce the percentage of sand. However, we still have the sand embedded in the bark.

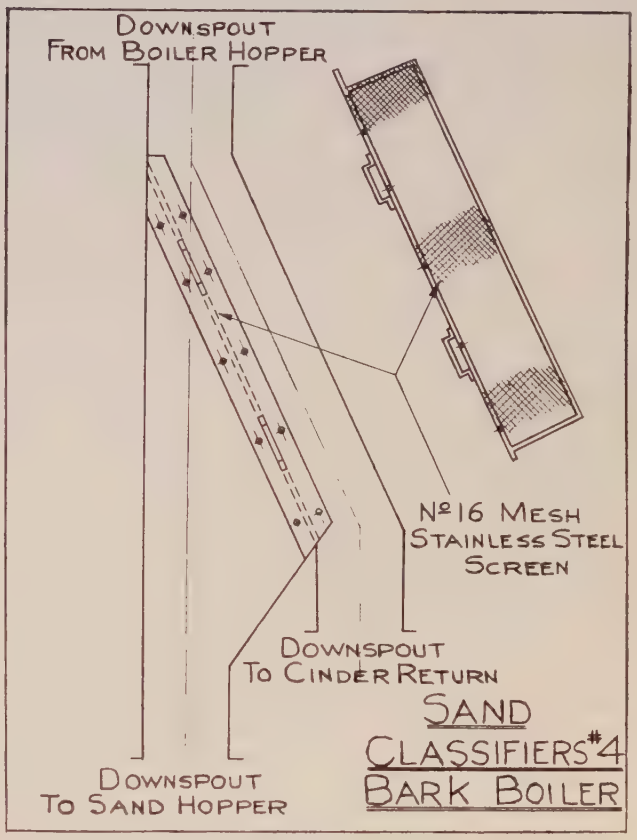

DOWNSPOUT FROM BOILER HOPPER
Nº16 MESH STAINLESS STEEL SCREEN
DOWNSPOUT TO CINDER RETURN
SAND CLASSIFIERS #4 BARK BOILER
DOWNSPOUT TO SAND HOPPER

Fig. 2

Pulp and paper mills must be kept clean if top quality production is to be maintained. Several factors necessary to realize this are by the full cooperation of burning equipment and cinder collecting units manufacturers, by careful operation on the part of the operators of the bark-burning units, and the interchange of information, all of which should result in higher burning rates with efficient units and clean and clear stacks. Certainly one of the best means of accomplishing this is during a Round Table Conference at the Annual Engineering Conference of TAPPI. After all, the most

outstanding question among all pulp and paper mills is whether we can put bark-burning units and collectors on the same high standards of production, efficiency, clean stacks, low over-all maintenance and operating costs, and continuity of service as has been established on coal, oil, or natural gas-burning units.

In closing, to show the importance of an efficient cinder collector, one mill recently installed a spreader stoker for burning bark without a collector and deposited 2 to 3 in. of charred bark all over the mill and community—after the installation of a collector, practically no charred bark was observed leaving the stacks.

Mr. Bollinger introduced C. A. Gallaer of the Buell Engineering Co., who outlined types of collectors for use on bark-burning units.

Mr. Gallaer: Buell offers two general types of dust collectors for use in the collection of fly ash from bark-burning boilers. One type consists of high efficiency cyclone collectors; the other type is a low draft loss collector consisting of a primary concentrator made of pipe vanes which concentrates the dust into about 15% of the total volume of gas, and a secondary cyclone, in which the dust is removed from that 15% of the gas. The high efficiency cyclones do a very good dust collection job, and, when used for the collection of bark fly ash, collect in the neighborhood of 90% or more of the total dust. The low draft loss collector, as its name implies, has the advantage of a low draft loss but its efficiency is not quite as high as that of the cyclones, particularly on fine dust particles. When used to collect bark fly ash the efficiency of this type collector is usually in the neighborhood of 80%.

These two types of dust collectors have been used very successfully for years in the field of fly ash collection from coal-fired boilers, and they have also been successful in the collection of fly ash from bark-burning boilers. However, there are two special problems in connection with this latter use which must be taken into consideration. One of these problems is the erosion in the dust collector caused by sand which is mixed with the original bark when fed to the furnace for burning. This erosion is especially pronounced when the collected fly ash is reinjected into the furnace for reburning. After this collected fly ash has re-entered the furnace a certain amount of sand is carried with it. This sand, of course, is not burned and much of it is carried out with the gases to re-enter the collector for a second time. As this cycle progresses, the concentration of sand entering the collectors is tremendously increased, as this sand can only leave the system by (1) escaping the dust collector and going out the stack, or (2) being trapped in the furnace ash. It has been our experience that only a small proportion of the sand is dropped on the grates and consequently there is a very heavy sand load entering the dust collectors. This sand will, of course, increase the rate of erosion of the dust collectors, and in some extreme cases, has eroded them very badly in as short a time as one year. One solution for this problem, of course, would be not to reburn the collected fly ash. In installations of this type we have noted very little wear on the dust collectors. Unfortunately, however, this solution is a waste of valuable fuel as a great deal of the collected fly ash is pure carbon, and also creates a disposal problem. Another and more economical solution is to reinject the collected fly ash into the furnace for burning, but periodically purge the system by discharging the collected dust for a period of time sufficient to remove the concentration of sand from this dust. In this discussion of erosion, I have assumed that the collectors are being operated correctly. However, erosion can also be caused by allowing the dirt hopper to become overloaded, or allowing air to filter through a faulty hopper valve.

The second special problem which I mentioned is that inasmuch as this dust is practically pure carbon, it is highly combustible and is generally collected at a temperature sufficiently high to initiate combustion when in the presence of oxygen. Any small inleakage of air into the hopper of the dust collector will therefore start combustion in the collected dust and create a fire which may seriously damage the collectors. The solution of this problem is of course to prevent such air inleakage by using a suitable hopper valve, and to promptly repair any cracks or openings which may appear in the hopper.

Mr. Bollinger then introduced R. Ellwanger of the Chesapeake Corp. of Virginia to present information on the recirculation of fly ash and distribution of air in regards to sand in their recently installed bark boiler.

Mr. Ellwanger: A discussion of this problem is naturally very complex because of all the variable factors involved. The most important consideration being the various dust loadings encountered, which are a direct function of the method of firing and the combustion principle involved. For those present who are not familiar with the suspension burning furnace in use at Chesapeake Corp. at West Point, Va., suffice it to say that this unit employs high temperature (500 to 550°F.) air at static pressures of 3 to 6 in. combined with extreme turbulence of overfire using the high set spreader method of firing applied to a traveling grate stoker.

This unit is exceedingly flexible in the various combinations available on arrangement of jets, pressures, speed of spreader stoker, speed of traveling grate, proportion of underfire to overfire air, and use of reinjection fly ash venturis. We employ a Western multiclone dust collector having 21 tubes of seven wide by three deep for collection fly ash and carry-over.

Numerous test runs have been made with a multiplicity of arrangements of the aforementioned variable factors, but in a short discussion I am not at all certain that any concrete conclusions can be arrived at except to state what our experience has shown to exist.

With all overfire jets off and practically all combustion air under the traveling grate stoker, and employing reinjection, a dust loading to the collector was obtained of 4.15 grains per cu. ft., and to the stack of 0.415 grain per cu. ft. This is naturally to be expected since a major portion of the sand redeposited on the grate is re-entrained in the exit gas stream.

Using tangential overfire air jets in conjunction with rear wall jets of approximately 30% of the total air under the grate, and employing reinjection, a dust loading to the collector was obtained of 2.72 grains per cu. ft. Duplicating test No. 2, but with only tangential side wall jets used, a dust loading to the collector was obtained of 2.59 grains per cu. ft. Under the best possible combustion conditions we have determined that the efficiency of the dust collector has been between 88.0 and 94.3%.

Question—What percentage of sand do you have in the bark entering your boilers at Charleston?

Answer—The exact percentage is not known but recent tests indicate that as high as 50% *by weight* was sand of the foreign matter leaving the stack.

Question—Mr. Gallaer, how long would a cyclone type collector stand up if 50% by weight of the fly ash were sand?

Answer—I cannot give a definite answer to this question but I am sure there would be erosion in the cyclones.

Question—What is the moisture content of the bark in and around the Charleston area?

Answer—Between 40 and 60% depending upon the season of the year.

Question—What percentage of the steam is produced by the bark-burning units at Charleston?

Answer—Around 18%.

Question—Mr. Bollinger, what methods have been used to eliminate the sand before it enters the boiler?

Answer—This is a very good question and we have been looking for the answer. However, one large mill in the South recently replaced their wood conveyors with water flumes and they reported a reduction of over 50% of the sand entering the boiler with the bark. Another mill washes all of its

wood while on chain conveyors and they report that they are removing a good percentage of the sand.

Question—How do you handle the sand in the West Point boiler?

Mr. Ellwanger: We think we are a little bit unique in being able to handle this sand problem. I don't know what proportion sand we have in comparison with Mr. Bollinger's plant but I presume it must be comparable because we are not too far removed geographically. We have found that when we are running under high loads and I mean high loads—now this boiler was designed for 90,000 lb. of steam per hr.—we consistantly run that boiler on high loads to 160 to 170,000 lb. of steam per hr. for 3 and 4 hr. at at time. We have four 4-in. steam venturies in the rear wall of the furnace about 6 ft. off the grate and two 6-in. venturies in the side walls about 3 ft. 6 in. off the grate. Those venturies are discharging their load of sand and pure carbon in area of low turbulence. In other words, the overfire air jets are above the range of the venturies so that when the carbon and the sand are reinjected in the furnace they go into a low turbulence area and settle down on the grate. That is proved—it is not an assumption because we actually see anywhere from 2 to 6 in. of solid sand being discharged off the leading edge of the traveling grate stoker to the ash pit. Our grate runs at a speed normally of 8 ft. per hr. so that anywhere from 2 to 6 in. of sand being continuously discharged to the pit indicates that the sand is being brought back and once it is brought back it stays on the grate and does not get re-entrained in the gas stream. I assume that probably a very small percentage must be entrained in the gas stream. It is a little bit early in the picture to say how much sand erosion we have because we have only been in operation nine months on the boiler but I can say that after 8 months I myself went all over that boiler from stem to stern and calipered all the tubes and found that a large amount of erosion was 0.004 in. on the OD of the boiler tube which is practically negligible. At all turns of the passes I didn't find a single sign of erosion. It was very difficult to make an inspection of the cyclone but I don't believe there was very much there—at least what I could see. We are operating at a little bit of a disadvantage because our precipitator was set up for running at 90,000—of course, we are pushing the boiler to 160 to 170 so we are taking about a 4-in. drop across our dust collector which certainly is not a very good method of operation. It sort of puts the manufacturer behind the "8" ball but we are taking steps to correct the high level on the boiler.

Question: Not heard.

Mr. Ellwanger: In burning bark there are three main things which I think should be considered. First of all bark has 40 to 60% moisture in this area—I know that Canada has a lot more—than you have the volatile and those two must be driven off before you finally get to burning the carbon particles. It burns very slow and we in this particular installation which I showed on the screen have found that a lot of consideration should be given as to the exact point of the air. That seems to be important and that is one of the things that we tried to bring out in this particular discussion.

Education of Power Plant Personnel

M. F. Schnaufer

Managements of most pulp and paper mills are confronted with the complex problem of how to train new power plant personnel and bring old personnel up to date in the operation of complicated power equipment, the design of which is being constantly changed and improved. Progressive management realizes that there is probably no occupation in the mill upon which so much responsibility rests to insure maximum production and safeguard the millions of dollars invested in power and steam-generating equipment.

Past experience indicates that the old theory of placing misfits from the pulp and paper mill in some job in the power plant is not only detrimental but also costly. Many mills are becoming aware of the necessity for additional education for employees other than those of the laboratory.

To be successful, a training program must be well planned and managed as a long-term investment. Management must be sold the merits of such a program. To inaugurate a program of this type, we must emphasize the selling ideas, namely:

1. Industrial training must have an immediate and recognizable objective.
2. Training must suggest itself as a practical solution to a given problem.
3. Training must offer a personal benefit to all concerned.
4. A training program must have the full support of top management as well as the employees involved.

Assuming that these reasons have sold management the need for such training, we have the following facts to sell the employees and union, namely:

1. A means to train an employee for future promotion and training.
2. Text, visual aids, and classroom facilities are provided free.
3. The better courses available in the power field, with first-hand practical know-how.
4. A program sanctioned by management as a prerequisite for worth-while promotion.

The extent and type of training courses offered will, of course, vary with the size of the plant and the type of facilities involved. For the larger power plants, training courses are supervised by an educational committee, directed and conducted by an instructor usually furnished from the power plant. The curriculum may vary with the type of equipment. For example, the following is the curriculum offered by the Dow Chemical Co. for the employees of its Midland plant:

Operating Department

Firemen

1. Burner and pulverizer course (24 weeks).
   Prerequisite: None.
   This course is the most popular one to date and is the best course for a beginner to get acquainted with the power division. It consists of the type, design, related equipment, and operation of burners and pulverizers. Included are the simple elements of combustion, such as the composition of air and fuel, combining weights, heat of combustion, analysis of gases, excess air, and soot blowing.
2. Feedwater equipment course (24 weeks).
   Prerequisite: Burner and pulverizer course.
   Note: Dispatchers are exempt from prerequisite.
   This course consists of design, function, related equipment, and operation of feedwater equipment, operated by, or responsibility of the firemen and engineers. It is not a chemical course in any sense and deals entirely with feedwater equipment, as the title implies. The equipment covered is feedwater pumps, all water lines, deaerators, heaters, blowdown system, water sources, regulators, etc., for 1250 and 400-p.s.i. systems.
3. Cyclone boiler (12 weeks).

Engineers

Prerequisites: All firing courses except class A engineers and dispatchers.

1. Steam turbine and generator course, part one (20 weeks).
   This will consist of general designs, types, care, maintenance, and operation; electrical terms related to and lubrication of turbo-units.
2. Steam turbine and generator course, part two (24 weeks).
   This part of the course will concern power equipment with special emphasis in regard to operation. It will cover all turbines, generators, air compressors, water pumps, and their auxiliaries installed at the plant.

Dispatchers

1. Switchboard and control (future).

Maintenance Department

Prerequisite: Burner and pulverizer.

1. Power maintenance, part one (48 weeks).

The course is designed to fit the general requirements of the power maintenance department and is comparable to those offered in other industries.

2. Power maintenance, part two (24 weeks).
   An advanced course related to the subjects given in part one.

INSTRUMENT AND CONTROL DEPARTMENT

Prequisite: High school graduate. Physics or chemistry for number three.

1. Electrical course (48 weeks).
   Prerequisite: None.
   This is the standard electrical course offered by the educational department, with extra classroom work and explanations pertaining to power equipment.
2. Instrument course (48 weeks).
   Prerequisite: Electrical course.
   This is the standard instrument course offered by the educational department, with emphasis on power instruments.
3. Water conditioning course (48 weeks).
   Prerequisite: High school physics or chemistry, or equivalent.
   This course was primarily designed for all personnel directly connected with the analysis and treatment of water in the power division. Every phase of water treatment physically and chemically is covered with injections as required pertaining to our own methods or equipment.

Smaller power plants, of course, could not undertake such a large task, and probably the extent of training is not so great. Therefore, alternate types of courses are desired.

In Detroit, where city ordinance requires practically all power plant personnel to be licensed by the city, the public school system is now offering a four-year course of day and night classes. The curriculum includes mechanics, boiler setting, pumps, feedwater, separators, combustion, water treatment and gas analysis, piping, ventilating and heat exchangers, electricity, steam engineering, turbine, refrigeration, central station practice, diesels, etc. This type of public program relieves management of much responsibility and expense, but usually some training must be given new employees to further acquaint them with the eccentricities of pulp and paper mill operation. The Detroit Public School System inaugurated these courses because the need for licensed power plant personnel became acute due to the retirement of older operators and insufficient younger men able to pass the strict city license requirements.

MR. SIBLER: I want to thank Mr. Schnaufer for his very interesting presentation of something entirely different from what we generally discuss. It sounds to me as if it is a hobby of his and I think it is a very good hobby.

I want to thank everybody for the fine attendance we had in the morning and the afternoon. As I said this morning, I wish you people would help us put on better meetings by sending in suggestions on the subjects that should be discussed.

Electrical Engineering Discussion

EDITOR'S NOTE: Mr. Baker presented a preliminary report on the power requirements for press sections of paper machines. The final report is published on pages 390–394 in this issue of *Tappi*.

MR. CROCKER: Did you have any relation at all between the amount of water removal and the amount of power required to drive that press?

MR. BAKER: Our questionnaire included no data as to water removal. It covered the first, second, and third main press sections, and I presume that operating practice would necessitate that those values being pretty close to a uniform value on those machines. I know that they are different on the first, second, and third press and, therefore, it would indicate that water removal has very little relation to the power requirement other than the amount of nip pressure applied to the nip.

We had a number of readings that were recorded for common felt operation—we discarded those because we had no way of evaluating between power requirements as they were distributed.

MR. OSBORNE: I had an experience the other day of a doctor on our smoothing press that seemed to load us up when we got to 1900 f.p.m. Our smoothing press was sized by TAPPI data and constants, and the motor was overloaded. The important load on your smoothing press, I think, is the doctor.

MR. BAKER: Undoubtedly it is and possibly that is a limitation of the questionnaire. We could not ask all of the questions because we were considered pretty much of a nuisance in getting the data which we received in asking the questions which we did ask but we felt very highly pleased with the cooperation which we got and, inasmuch as the data included a number of smoothing press readings, I am inclined to believe that they must adhere to common operating practice in the use of doctor blades.

MR. SHAAD: You say that from the questionnaire that the Plastometer of the rolls didn't seem to give any clue in increased horsepower with high Plastometer rolls. Did you have any occasion to check any machines with double felt nips through a common press? I have seen a couple of machines where running another felt through the press nip seemed to increase the power around 30%. In other words, let us take the press section of a Yankee machine where you will have both a top and bottom felt going through the same felt press.

MR. BAKER: I can say that our questionnaries did not identify any machines as having double felts operation although they may have had. I might say that there were very little data that we received covering tissue production or Yankee machines. We did have a few readings on Yankee machines which we tried to include with our evaluations but most of the data were on plain presses, typical fourdrinier machines.

ANON.: When I talked to Mr. Mikelson I asked him if he didn't think it could be possible that we might determine some relationship which would exist between the power requirements of couch sections and the work they were doing—by that I mean suppose you were running a 30-lb. kraft sheet at 1500 f.p.m. and you would take the power requirements of a group of machines that were all running around that range if you wouldn't find some relationship that would exist between the amount of water removed and the power requirements of that section. It certainly would be influenced by the freeness of the stock but if you use the same criteria, the same class of machine for a group of data that would eliminate that one variable and we would get information on one class of paper and then if we used a 30-lb. with a given thickness of sheet we would have about the same freeness on these various machines. I wonder if we wouldn't find that there is a definite relationship which exists between power requirements and the classification of machine. I am saying that because I feel it is going to be very difficult to attempt to apply constants to couch sections when no one is going to know what the vacuum conditions are going to be.

MR. MIKELSON: I don't have any specific answer to that question but it is another approach and it might be possible by cranking in the water removal and the freeness of the stock and the thickness of the paper to end up with a horsepower figure. I think that this formula which was described today does that through the mechanical measurements that you might make on a machine rather than the constants of the machine.

ANON.: It is possible to predict approximately what the vacuum is going to be based on experiences with other machines making the same kind of sheet—isn't it?

MR. MIKELSON: It is possible in some cases—I think that in the majority of the cases the vacuum is not known too well on fourdrinier sections, which I think is what Mr. Baker is bringing out, and that is true primarily because of poor instrumentation. I think that machinery builders and also

papermakers are taking steps to correct that so that they do know more about what is going on at the flat box. I think, to date, instrumentation is not sufficiently adequate to get any very exact figures on flat box vacuums. I think in the future it will be.

ANON.: Doesn't this mean that if we are going to predict the horsepower requirements for fourdrinier sections of paper machines that in the future we are going to have to get enough vacuum experience to do so successfully? If you haven't got it then you can't predict the power requirements and if you are going to be able to then you have to get experience in predicting the vacuum.

MR. MIKELSON: I think Mr. Baker's approach is another approach and I would certainly like to see him progress it as far as he would like. If anyone else could contribute information which would be useful in trying to approach the problem from this other direction please send the data to Mr. Baker so he could analyze it. After that has been done we can compare the two methods of evaluating fourdrinier horsepower and arrive at a figure as to which one is the more applicable of the two. I think right now it is a little difficult to compare them quantitatively. The readings taken on the flat box—most of them were taken at the back side of the machine. In one case readings were taken at both front and back but most of the time they were taken at the backside of the box.

MR. DREW: You do not have a true picture of what your average vacuum is. When you are talking about vacuum on the flat box you say there are very few flat boxes equipped with vacuum connections on them. In the questionnaire you ask the vacuum at different points.

MR. MIKELSON: It was requested that vacuum gages be put on the flat box and in some cases it was done and in other cases it was not done and in all cases it was requested that a one line diagram be supplied of the suction system, together with pipe diameters, valve locations, vacuum gage locations, and so forth.

ANON.: On a 500-hp. couch motor you have 50 hp. as the vacuum load—on the inside of your roll, why can't you locate it on the press motor and why can you isolate it on the couch motor?

MR. MIKELSON: Perhaps Mr. Baker would like to comment a little bit on whether or not it could be isolated on a press motor—if you would remove the vacuum would you notice any change in current?

MR. BAKER: As covered by the preliminary report you will note that it covers vacuums on presses ranging from very light vacuum to comparatively heavy vacuum and yet there is no correlation that existed between horsepower requirements and those vacuum meters.

ANON.: Mr. Mikelson, you were able to record a difference in the friction value as the wire wore on the boxes. Isn't it likely that there is a considerable difference in the friction value for the different type of materials used on boxes and also whether the sheet is loaded—there are so many other factors that come in there—I wonder how much data you can get on that.

MR. MIKELSON: I would like to get all the data that you mentioned but we have not been able, to date, to get enough data to arrive at any conclusion with respect to how friction varies with flat box covers.

ANON.: One particular case that I know of had a wire life of approximately 17 days and by simply changing the shape of the holes on the top of their boxes they were able to increase that to 30 days. That wear was certainly going into friction.

MR. OSBORNE: I would like to carry on this little discussion and just sort of clarify my own mind. By the way, I certainly think you have done a fine job in preparing your report—I want to comment on it. In Fig. 6 of your preliminary report with the 48, 64, 80, and 96 as plotted against the old TAPPI recommended constants for couch sections—it looks like from this and I agree with Mr. Baker that we would normally expect that all of our—if we powered our couch motors from the old TAPPI constants that they would be underpowered whereas that is not true when actually we don't have the flat box vacuum that we think we have. Actually we fall down in the lower left-hand corner below the TAPPI recommended constants. The reason for my bringing that up is that I wanted to clarify in my own mind the point that generally every couch that I have seen the horsepower of the motor was according to TAPPI constants and had been overpowered some two or three times in power. This is correct, isn't it?

MR. MIKELSON: What you say can't be overemphasized—that is absolutely right in that what we need is better instrumentation on flat boxes. I don't say that just to make it it easier for electrical manufacturers to determine motor horsepower sizes but I think that the papermakers have a lot to learn if they equip themselves with better instrumentation on flat boxes. I think that point was fairly well indicated at the conference on water removal. There is usually a vacuum of 2 or 3 in. at the flat box and that is needed to take care of water removal whereas generally the header vacuum that you measure is a little bit higher than that.

MR. DREW: We have flat boxes separators and on those separators we carry cut straight into the vacuum on a wet box. From those readings you have there do you have any idea what that corresponds to on your suction box readings?

MR. MIKELSON: I would like to ask the general question—do you consider your stock to be on the free side or on the slow side? Just guessing I would say that it probably corresponds to a vacuum around 3 or 4 in. at the flat box.

MR. DREW: I know from my own experience that if you turn the papermakers loose on a machine that they can do most anything to your power consumption or what have you. You have to watch your vacuum on the flat boxes or you are liable to overload the machine. This is all very true but there is another consideration that maybe some other manufacturers may be interested in and that is if your drop legs are not long enough and you try to carry too high a vacuum you get a slugging on your flat boxes. In other words, what you do you pull the water clear up until they are practically submerged and then the first thing that happens is that the papermakers get out and they howl that the control is no good. I just submit that for whatever it is worth to any of the boys in the electrical manufacturing business who are called in to find out why the couch motor is bad and that is one thing you can look for.

MR. MIKELSON: I might add that during the discussion yesterday on water removal with Mr. Clark as the moderator and a panel of about six people that it was suggested that gages of large diameter be used instead of these little ones with the glass broken and the needle bent on the front. We should have large sized gages on the front and back which can be seen clearly—either the dial indicator type or the column type and maybe even record the vacuum in these boxes for awhile just to make the papermakers take cognizance of what effect the vacuum might have and light them up at night. I think that is an indication of the trend at the present time.

MR. MIKELSON: I might explain coefficient of friction chart a little more clearly—the first plot appears to be a 4 point plot—actually it is four spot readings—that is four spot readings taken on different wires during different periods of their life. For machine C the peak reading was obtained right after the box covers were dressed. The coefficient of friction appears to be quite high for a very short period of time, apparently until the wire has smoothed over the roughness caused by the dressing. The remaining curves were not plotted on strictly a time basis—the curves indicate that the friction goes up linearly with life—actually it takes some curvature—I just drew a straight line between the starting point. I think we can always use more data.

MR. BAKER: I have known of and I guess all of you have known of clipping wires on fourdriniers and when the tension gets too high for the roll to turn and I am wondering in this area over here whether he wouldn't be exceeding the tension capability of the wire itself or the ability to transmit power through the rolls themselves.

ANON.: Doesn't that depend a lot on the machine and the type of stretch that you have and soon?

ANON.: The wires as I understand it have sensational stress so probably you might not break the wire but your problem of roll clippage I think is a problem and it would depend to some extent upon the roll diameter as to what your friction will be. There has been a tendency of late, I think, to make couches larger just to eliminate that roll clippage and to drive the wire under a heavier load.

MR. MIKELSON: I am wondering if the committees couldn't get some recommendations—it is a factor that involves our application and I think we would get some direct information from the various fourdrinier builders as to what tension they can tolerate.

MR. OSBORNE: We at Crossett—we had 300 hp.—put 200 of it on the couch roll and 100 wire drop roll that had a much larger wrap and in that way we split the roll up. I think Mr. Baker is absolutely right that slippage is an important thing. The power that we are using is only in the nature of 100 or so horsepower out of the total at 1500 f.p.m. but at 1900 ft. we are using the total amount of power. We have an over-riding vacuum control that we have installed on the couch roll so if we do lose our vacuum there we are not trying to keep the machine up to speed—it over-rides and limits the amount of power in the couch and slows it down. It is a very narrow little box in there that is dragging the wire along and the couch can't transmit too much power—you will get slippage.

MR. KNAPP: Do you have any test data on the wire vacuums on the boxes and if so how many readings and on what machine, where there are any indications of slippage?

MR. MIKELSON: We do have several—the highest one was twice TAPPI's; instead of constant 0.1 it was constant 0.2 and we tried to find out what effect increasing the vacuum did have and we watched the motor closely and measured the temperature and looked for flying solder but there was no indication of any slippage. The vacuum at the couch was 24 in. which was also a pretty good sized vacuum. I think there is a point there somewhere that Mr. Baker mentioned where you have gone so high that the wire life will be very poor—we don't exactly know where that point is. The highest continuous operating vacuum that we know of at the flat box is an average vacuum somewhere around 6 in.—perhaps that curve might be chopped off at the 8 or 10-in. mark. I don't know whether we will ever run into any actual operating condition where the average vacuum to the flat box is going to be more than 8 or 10 in.

MR. BAKER: I think it would certainly be desirable if it were possible to determine power based on what the machine is going to do and its design rather than the proposed operating practice. In other words, if some correlation could be found between what you are going to make on the machine you know that it is going to be pretty much a conventional fourdrinier machine and it will have so many flat boxes available in the first range that that fourdrinier will remove a certain percentage of the total water content (unable to hear the remainder of Mr. Baker's comments).

MR. MIKELSON: That is correct—at the present time in most cases it is necessary to assume a vacuum. I think that the method described in the report is a direct method of getting at the answer based on purely mechanical considerations and if we are able in the future to get more data to get these flat box vacuums more clearly defined than at the present time perhaps it will work out to be extremely useful. On the other hand, if we can't then another approach may be a better approach. I would like to see some data accumulated on the subject and I understand that you are doing it right now.

ANON.: Perhaps freeness might not enter in as much as pounds of water removed for pounds of paper produced. I am saying that variations in that range are not as wide as you possibly can get variations in a flat box vacuum.

MR. MIKELSON: We have a lot of operating experience on newsprint machines—we have where the same weight of sheet is being formed, not always out of the same stock but stock that is essentially of a similar characteristic, and we have all of that data to go on and I believe that there is a definite relationship between the speed at which they are making newsprint and power. The same line of reasoning can be applied to any grade of paper that will have characteristics that are quite similar throughout the range of manufacture of those grades of stocks.

MR. DREW: We used to be able to buy a 10-hp. motor and be able to run it around 12 or 14 hp. without getting into too much trouble. We got the motor size down now if you put 12 hp. on the thing you might as well go get yourself another motor. When you size the motor to drive a paper machine for goodness' sake let us keep it liberal enough so that we will not end up with any undersized motors on our paper machines because regardless of how close you figure this thing you will never be able to get all of the conditions. I think you have to have a very liberal safety factor because from mill to mill you find that it will vary and from paper machine to paper machine you will find that it will vary. A manufacturer builds his reputation on how his equipment will stand up regardless of whether the machine manufacturer or the papermakers told him in the first place that a 350-hp. motor was big enough to pull that couch. He is in trouble if when they put the equipment in operation they find out they use 375 hp. and you run into trouble right from the start and nobody remembers that they told him that 350 is ample for his motor to run.

ANON.: Another thing that I would like to add to what this gentleman said about having plenty of capacity—you never know what changes are going to be made that may require more power and it is always a safe feeling if you have about 50% more to go on without having to change the motor. We have run into that already and the men responsible in our mill have always gone to plenty of overcapacity and we haven't had to increase the size of the motor and we are running near the top now.

Drying and Ventilating

MR. BARKER: The first talk this morning will be by Charles Spalding from the Beloit Iron Works on high pressure driers. I know that down in the South here you want all the steam you can get to get that production out and I know that you will be interested to hear what he has to say this morning.

"High Pressure Paper Driers," by C. P. Spalding (*Tappi* 35, No. 6: 258–259 (June, 1952)).

MR. Spalding purposely made his talk short and sweet so as not to bore anybody but on the other hand we want you to feel free to ask questions and develop any ideas that you have in mind or any information you have.

MR. CRAWFORD: With reference to the risks that have to be taken concerning high temperatures with groundwood and similar materials, I believe that Federal operates at 175 lb. pressure in some of theirs, or 125—I am not sure which it is—on folding grades of boxboard. Are there any others here who operate at higher temperatures on grades that have used news as a filler, for example?

MR. SCHNAUFER: Does the finish on the Yankee drier have any effect on the drier rate and, if so, how do you determine the microfinish. What is considered a good finish on a Yankee drier?

MR. SPALDING: We use an arbitrary standard for finish but I don't think that the finish makes much difference in the drying rate. Sometimes the Yankee will go out of shape and have a low spot and then you can't iron the sheet onto the Yankee and get good contact. That spot then will not dry as quickly as the rest of the sheet and you will have a wet spot at that point. We are more interested in the finish of the Yankee from the standpoint of appearance of an MG sheet than from the drying rate. If you had a lot of little pin holes in your drier and didn't finish those out you might get pin holes in the sheet as you take the sheet away from the drier. But I don't think, except for the appearance of the MG sheet, that the finish is so extremely important. Don't misunderstand me, you want a very good finish and if you are going to have an MG sheet you want as perfect a finish as you can get. At our shop we have a series of plates that are set up as standards and we compare those plates to the finish on the Yankee itself.

MR. BARKER: I had one thing in my mind which I thought might be of interest to Mr. Spalding, if he is free to talk about it for a few minutes, and that is the Dowtherm material or system in use in the driers instead of using steam. Are you free to talk about that at all?

MR. SPALDING: It is possible to use Dowtherm to get high temperatures at low pressures, but it is quite a different animal than steam to handle. It has very low latent heat, therefore, we have to handle a large amount of gas to do the work, and it is very hard to get a large enough entrance into your drier, resulting in a terrific friction loss. The second trouble with Dowtherm is that it is very hard to hold in the system. It will also turn your hair yellow, I believe. Although we have discussed it with various customers at various times, we have never come up with a very good answer. We have used gas fired heaters, driers having a gas flame, but they have not been too satisfactory. Of course, the main thing in a standard plant is to have steam available and that is the easiest thing to use if you can get the temperature you want with the steam available.

ANON.: Mr. Spalding mentioned the drop of temperature to the inner film and to the shell and from the shell to the sheet. Would you care to tell us how you tested and measured those drops?

MR. SPALDING: We used standard data sheets for the internal film, that is about 2000 *K*. All the books give you that. We never tested it but assumed that it was about right. For the *K* through the shell itself we used the General Electric data sheets for cast iron of the type that we have, and we cross-checked by testing a series of plates that we cast in our own shop. We took different grades of cast iron and they checked up pretty well with the General Electric data. We did find that the best thing to make driers of would be stove metal if you could hold it together. Then we arbitrarily took the film coefficient between the sheet and drier surface. We had the two other coefficients and solved for this coefficient from various drier sections—we used this arbitrarily because each type of sheet dries differently and you get a different film coefficient, so we assumed an arbitrary point to get this approximate figure. We did the same thing with both the Yankees and with the paper driers.

MR. SUTHERLAND: When you talk about 125-lb. driers, is that operating pressure or is that where you have to have your pop valve set?

MR. SPALDING: That is up to the insurance company. That is, as far as we are concerned, the safe operating pressure for the drier. It has been tested and approved by the insurance company in accordance with the ASME code for 125 lb. operating pressure. There is a big safety factor, almost a 10.1, in some of the driers, and usually your insurance company will allow you to have your pop valve set 5 to 10 lb. higher than this pressure. But sometimes on older driers, the driers that are a little bit shaky, they insist on setting the pop valve at just that pressure, but that is up to the individual insurance company.

MR. CROCKER: Have you any figures at all on a conventional drier stack showing the difference in the drying rate when you have more distance from one drier to another before making contact after leaving one drier?

MR. SPALDING: I am sorry to say I haven't. I would like to see that myself but there again, if you have an efficient ventilating system you can get the driers closer together than if you had a poor ventilating system. I am thinking of one mill in particular where they felt that their trouble was due to the driers being too close together. They increased the efficiency of their ventilating system in the pockets and corrected this condition.

ANON.: I have always been curious how far they could go on a cold water hydraulic test on driers before they let go. We tried 100 lb. on what was supposed to be 25-lb. drier and that didn't bother it any. We were afraid to go higher for fear that one of the boys would get hurt, but I would like to ask Mr. Spalding if they have done some testing on that—put the pressure up to where they really let go and see how many pounds of steam pressure the drier would hold.

MR. SPALDING: In designing a head for a drier the standard code formula usually cannot be used so when we want to make a code dryer for say 125 lb. we design and cast a head and that head has to be tested to destruction. So for every type of head that we have a code drier has been tested to destruction and they allow about eight times the operating pressure for the breaking pressure. In addition to that, recently, we have done two other things: we have covered these heads, as we test them hydraulically, with stress coat to determine where the weakest point in the head is so that on redesign we can correct it. We also test with little strain gages to get an accurate measurement of the strain at the various parts of the head.

MR. GREGG: One of the things that has always worried me as an old B.t.u. chaser was the heat loss on the ends of the rolls. Is anything being done towards insulating them to prevent heat transfer on the ends that are exposed?

MR. SPALDING: I believe there was a patent issued to somebody recently using a different metal on the head, stainless steel or something like that, to decrease the loss through the head, but in general the loss through the head itself is not entirely a loss. In the first place, of course, most of your heat is going from the shell to the paper. That is your high heat transfer rate because the paper is wet and you get a much higher heat transfer, while the loss through the head being a transfer to air is much lower. Secondly, the heat from the head is heating up the air that is ventilating the hood so it is not really all lost. I don't think you would gain too much by insulating your head though some heads have been insulated. It is perfectly feasible to insulate a head but it hasn't been found necessary to do so.

MR. CRAWFORD: I would like to rephrase the earlier question—to what steam pressure or temperature do you think we could go without risk of damage to groundwood?

MR. SPALDING: I am not a papermaker and I don't know. They vary all over the map. I think it depends upon the individual sheet you are making and I would like to answer that question but I can't. I am just going by the reports that come in to us, of course, and we are a little conservative maybe on that. I know of companies that have increased their drying temperature on some special boards and claim that their folding qualities were hurt.

MR. SUTHERLAND: I would like to explore that question that was asked before about differences in temperature between steam and the surface of a drier. That is about the only way you have of checking to see whether your driers are performing correctly. We have found some down as low as 6° and in some machines we can't get any closer than about 20° difference between surface drier temperature measured

with a surface barometer and saturated steam temperature corresponding to the pressure in the drier. I wonder if you could give us some idea of what we should be shooting for—what we should expect.

MR. SPALDING: Are you talking about with a sheet on your machine or without a sheet? With the sheet on the machine the surface temperature depends first, on how much the steam pressure is and, second, on how fast you can pull that heat away from the outside surface of the shell. For instance, you wouldn't anticipate as high a temperature at the wet end of your machine as you would at the dry end of your machine. At the dry end of the machine where the *K* or the heat transfer is low, you would anticipate a temperature fairly close to the temperature of the steam but at the wet end where you are pulling heat out of there quickly you would then approach the temperature of the sheet. At the dry end I would think that you would get fairly close to the temperature of your steam. If you get a drier water bound or gas bound it will show up. Perhaps I am putting too much stress on the sheet being wet or dry because your *K* factor between the sheet and the shell is pretty low but I haven't any figures with me. I know we have them but I didn't come prepared on that question.

MR. MONTGOMERY: I think there might be confusion arising on that point of temperature difference due to the fact that the surface pyrometer doesn't necessarily measure the actual temperature. The reading given by a surface pyrometer is influenced decidedly by the speed of the drier surface and by the roughness of the surface and so we must not think we are actually measuring an absolutely true temperature.

MR. BARKER: We will be glad to go into that question some more this afternoon. We will give Mr. Spalding a vote of thanks on his talk. We are glad to have heard from him and I think he will be at the meeting this afternoon so if you have some more questions we can discuss them a little more fully at that time.

L. G. Janett of J. O. Ross Engineering will give us a talk on "Ventilation for Comfort of Personnel."

MR. JANETT: This past Summer has been one of the hottest Summers in the history of the South and I think those of you down here are well aware of that. We up North had one of the coldest on record—I am from Chicago—and I don't know all about this hot weather. After discussing high pressure driers it becomes apparent that that is another factor that is now coming up to increase the comfort problems that are in the paper industry in the machine room. I dare say that the jump is quite marked for as you know, the jump is from an average pressure of 60 lb. up to 100 and the difference in temperature is added to the thermal head which creates unfortunately uncomfortable conditions.

Materials Handling

MR. MCNALLY: The first two papers will be of quite a bit of interest because of the variations on the geographical sections which they cover and I think since we are running a little behind time we had better get rolling. The first speaker is W. H. Rambo consulting engineer from Portland, Ore., specializing in saw mills and paper mill work. He has been permanently identified with Soundview Pulp, Crown Zellerbach, and Rayonier and his paper will concern itself with operations on the West Coast.

MR. RAMBO: This paper I am giving you illustrates by means of 28 slides the most modern and up-to-date log handling devices in wood mills on the West Coast.

"Woodmill Log Handling in the Pulp and Paper Industry on the West Coast," by W. H. Rambo and H. A. DeRice (*Tappi* 35, No. 3: 100–107 (March, 1952)).

MR. MCNALLY: Thank you very much Mr. Rambo. The equipment certainly is a lot more rugged than we have seen in some of these mills handling smaller wood. C. L. Wills, Plant Engineer, Halifax Paper Co., Roanoke Rapids, N. C., will now show us and describe methods of handling wood in Eastern North Carolina and the Virginia area.

"Wood Handling Methods in Pulp Mills of Eastern North Carolina and Virginia," by C. L. Mills and C. L. Hildebrand (*Tappi* 35, No. 3: 137 A–143 A (March, 1952)).

MR. MCNALLY: We have seen various conveyors illustrated and explained in these two talks and now Henry Stoess from The Fuller Co. will describe the use of another conveying system which hasn't been covered. To those who are not familiar with the application it may open up new vistas to you and may be of great assistance in your expansion programs or in improving and modernizing the existing facilities.

"Pneumatic Conveyors in Pulp and Paper Mills," by H. A. Stoess, Jr. (To be published in the Oct. issue of *Tappi*.)

MR. DOLLEY, (International Harvester): We wrote Mr. Lientz and asked if they would be interested in our being here for the interest of any truck transportation problems and I wonder if being here is in order?

MR. MCNALLY: I believe it certainly is because the average mill is trucking. I believe it is within a 50-mile radius of the paper mill where they truck so that most of the mills, large or small, are depending upon wood from the local farmers. If you are a truck manufacturer or a trucking company representative I think you are certainly in order being here. The industry needs you assistance as well as the assistance of other people who manufacture conveying or carrying equipment.

ANON.: The truck of the South is entirely different than the truck of the North. The unloading problem is different.

MR. MCNALLY: We are getting away from the question that was first raised and which Fred mentioned—we were asking whether a small powered conveyor for unloading box cars would be an economical and practical piece of equipment to design, from the dollar standpoint—we are only considering that. You get less than 1 cord per man hour in unloading boxcars—you are paying a good wage to these fellows. Would a small conveyor, strong enough, pay for itself in a given length of time?

ANON.: . . . it means a lot of difference when you are talking about Northern wood and Southern wood too, because Southern wood is so heavy that a lot of the sticks cannot be handled by a single man.

MR. STOESS: I don't know as this is out of our line but with any type of wood or chip handling you have a certain amount of manual labor. With that mechanical unloader I think you will probably have to have some manual labor along with it. In that case, I would think that the economics of the design would be dependent upon whether they could be paid off in 2, 3, or 4 years or maybe 1 year and the fact that maybe if this war situation is over these mills might have rack cars. If that is the case then maybe a rotary dumper might be more the answer. I don't know but that is just food for thought. In the West Coast they are using open top boxcars for chips.

ANON.: You have a whole new lot of them up in Maine that have just been built and have got a side swing.

MR. MCNALLY: Incidentally they dump, because I have timed it, 20 cords of wood in 40 sec.

ANON.: But they are dumping it into the river and not into a conveyor.

ANON.: You can spill into a large apron conveyor which will feed your conveyor dam.

ANON.: Your wood is not all coming from the end of the car, therefore, you can't fit your conveyor in until you have your car about half unloaded and then you have to have a rubber conveyor in order to do that.

ANON.: What I am offering is an example—you got to get the stuff to wedge the car door before you can knock the car

door down. The same thing goes for pulpwood. There is certainly some kind of an arrangement for the car door to keep that wood from knocking the door out. First of all get your wood away from the door, after you get your wood away from the door there is more manual labor—until you get your wood back far enough to get your conveyor in the car.

MR. PATCH: Years ago I made a study of unloading boxcars. The West Virginia Pulp & Paper Co. very kindly furnished me with anything I wanted to do there and I made time studies putting one man in the car, two men in the car, three men in the car, and four men in the car as to how many man hours it took to unload the car. The most efficient way is to have one man. The next best thing is a left-hand man and a right-hand man because it is a fact that most people are trained either right or left handed and they do a better job one way or the other. If any of you people spade up a garden I am going to tell you something—if you learn to spade down the row right-handed and back up the row left-handed you can do your garden in about half the time than you can if you go only one way because you keep right on working instead of having to hang on the shovel and rest.

ANON.: Assuming for a moment that you have taken into consideration removing of the top of the boxcar. I mean assuming again that you have no choice in the matter that you had to use boxcars and can't use anything else then you could try to remove the top of the box car by lifting it up with your crane. Assuming that that is not impossible, I think that a conveyor which will go into a boxcar would greatly aid in unloading provided that the conveyor at the same time goes on top of the pile.

ANON.: There has been a lot of time spent in trying to design a conveyor to go into a boxcar and what you are always faced with when you get through is that it takes so long to set the conveyor up to get it in the cars that the time you would save using the conveyor hardly pays. We have never been able to design one that didn't have to clear out the doorway. By the time you have done that and got your conveyor in, the men would have the car half-unloaded.

MR. MCNALLY: That is what I have been asking—we would be wasting our time unless an individual mill would want one then we would design it and sell it to them but as a package item apparently it doesn't look like it is desirable. The thing that this particular outfit was concerned with was the last third of the end of the car on each end where the one man had to pick up the wood and carry it out to the door to throw it into the yard conveyor.

ANON.: It is important where that wood is going. If you have the right kind of a thing to receive it you could throw the wood from half-way up the car. If you don't you have to walk to the door with it. You can't do that with Southern wood because some of the pieces are so big you have got to get two men to press them out.

ANON.: I think that instead of a conveyor you could develop something along the line of a power shovel that could reach in with a hook—stick it into the log and snatch it out through the door. It could be made to work with a little study and it would be actually—particularly in this long haul type of car, but nobody has ever worked it out.

MR. HALL: I came down as an observer but I have to enter this discussion because I think you are wasting an awful lot of time. I found that our committee was wasting an awful lot of time thinking of the mechanical unloading of boxcars. We discussed some mechanical unloading of boxcars at the Howard Smith Paper Co. and, unfortunately, just about an hour before we held our discussion they took us out to their woodyard where they have an incentive plan for unloading box cars. They put two men in a car and a line of four cars on each side of this conveyor—put two men in each of the four cars—an hour afterwards these cars where backed in while we were watching. Two men that were at the end of the conveyor at the start of that hour and they were back at the end of the conveyor at the end of that hour and that the cars were out of there empty. They had cleared their track—they had done everything. That is incentive for you—you don't believe that—I know that 90% of the people here in this room don't believe that but it just ruined our discussion of our committee. If you can do that for a tenth of a man hour per cord you know how much you are going to get from management to spend on mechanical unloading of box cars.

ANON.: The problem is not only unloading it but loading it if you do it yourself, if the same company is loading it and unloading it.

MR. HALL: Obviously, it makes no difference who loads the cars. It is part of the cost and if a method can be devised for loading those cars more cheaply it would be worthwhile considering. In our area it is practically impossible to get the people to work on an incentive plan—the union situation the way it is those things are taboo. I have been associated with other industries longer than I have in the paper industry and there is no other industry that recognizes that—why should the paper industry recognize that.

ANON.: MR. Hall it is not a matter of whether you or I agree to it—it is a matter of fact. Several cases that I know of have had incentive plans for certain operations and the union insisted on them being removed—production dropped almost in half—gradually it worked up again so it was probably about 75% of what it was on the incentive plan.

MR. HALL: I may have been a bit vehement about it because it really knocked our plans for the meeting into a "cocked hat." We had a very nice plan that was developed at Ontario Paper which had to do with this loading, the way the wood was loaded and using a device which was suggested a minute ago in which they had complete figures—man hours per cord and so on—those tests have been run and there is no doubt about it that there are ways of mechanically unloading box cars that have been tested and the results are available.

ANON.: The point you make is that if you can put in an incentive plan you can't save enough by a mechanical conveyor or otherwise.

ANON.: The wood is loaded at fifty different points while it is unloaded on one and when you begin to talk conveyors you are talking a whale of a proposition.

ANON.: Aren't those small conveyors rather inexpensive if you can design them?

ANON.: It may not be a practical proposition for loading cars unless you were loading on a quantity basis.

ANON.: I can't say too much about it but I do know this. There is a mill in the Southeast that has gone into this proposition and they have found out that when the farmer has to cut the wood and bring it to their car on the siding at the time that they want it they are not able to get the wood when they want it. They have worked out a system wherein they have various men spotted throughout the siding area. The farmer can come in at any time and unload his truckload of wood on the railroad side and then when there is sufficient wood there the car is loaded. That is a situation that an individual company has done. This problem of loading wood—making your wood producer suit yourself to the big company is why you are having your trouble on your small loading, I think.

MR. MCNALLY: I think we are getting away from what we are after at this meeting—the sort of thing we want to know in order to assist Mr. McKenzie in a study which can well be of benefit to the paper mills all over this country and all over Canada is that from the producers that are here, paper mill people who are here—what particular problem is bothering you in getting from your wood line into your mill. I think we can be of assistance to Mac if we come up with something right now.

MR. HELVERSEN: We are stimulating saw mills which are removed from our immediate vicinity to put chipping plants, small chipping plants wherever the wood occurs. That means we are shipping chips instead of shipping the wood in. I would think about 150 miles. The reason for that is that chips are very much more easily handled than wood. In this

particular case bark is not our problem—we have too much at the present time.

MR. MCKENZIE: Under those types of conditions there are two types of chips that are shipped to the pulp mill in our area and that is what Fred is talking about—one is shipped from saw mills and they are bark-free—they put the bark-free wood in the conveyor or they debark it. The other is from fiber plants where they chip the green veneer away and that stuff is, of course, bark-free also. We don't use portable chippers in our area so far as I know. Up to now we haven't felt that that was economical but there is another angle to this thing that I think is worth consideration and that is the matter of portable chippers. There are some manufacturers in this part of the country that make portable chippers but whether it is more economical to haul the wood into the mill and chip it in the mill is something that I am trying to investigate.

MR. MCNALLY: You might check with National Container in Wisconsin—they have been bringing it in special trailers—bringing it in and dumping on a track hopper and run them in the mill. How efficient or how economical it is I haven't heard but they can give you some information.

ANON.: The matter of removing bark on small poles is something that is a problem in attempting to set up a portable chipping plant. There are some operations, of course, where that amount of bark probably doesn't bother them but it has been a factor that we recognize and so far no solution that we have arrived at. There are pole barkers you can buy that are relatively cheap and will remove the bark from the wood.

MR. MCNALLY: There is one mill in the Mid-West which is separating their chips and their bark by flotation and have been doing it for quite a number of years and it has worked very successfully.

ANON.: To answer your specific question—I do not know of any chipping installations directly in the woods.

ANON.: Camp Manufacturing is barking their logs in their saw mill before their sawing operations so they can chip their slabs.

ANON.: The only thing there is they are bringing their wood in at 20-ft. lengths. We can't concern ourselves with that because it has been operating for quite a number of years and has been successful. A lot of the other mills have gone to it so there must be some reason.

ANON.: The transportation either of your chips or your logs or your slabs or whatever you are going to have from its source to the woodyard is important.

ANON.: What we are talking about is transportation and not the matter of barking isn't it. The subject is interesting as far as the problem but it isn't really what we are supposed to be discussing.

ANON.: I think, however, there is a definite material handling problem whether you are installing chippers in your plant— we are interested in that kind of a relationship I would think.

ANON.: I think we could say that slabs are purchased from saw mills hauled to pulp mills and debarked and used in the pulping process and if any of you fellows want information about it there is no problem to get it for you.

MR. MCNALLY: I think what you are trying to bring out is that the problem is important in 48 states as well as 2 or 3. However, we are talking primarily on pulp wood being obtained and transported to the plant and to the woodyard, not regarding the barking end of it—that is another problem.

MR. MCKENZIE: You are attempting only to get the raw material where it can be further processed. If we go into this whole problem it would be never ending.

MR. HELVERSEN: Yes—I hope you don't overlook in your studies that there is one important factor—putting chip plants away from the mill——that will give continuous alibis to the pulp and paper people that they got some stock which isn't any good from 50 miles away. That kind of an alibi they do not have when the chip plant and the stock preparation is under the same management.

ANON.: May I ask a question which is beside the point of our discussion but somebody mentioned this flotation process of bark separation. I would like to hear a little more about it if anyone would care to mention it.

ANON.: I don't know—I have no reason to inquire whether you people have any special equipment for delivering wood either from the wood lot on open highways or captive trucks. I know of a mill up in Pennsylvania where they have two captive trucks which cannot operate on the main highways. These two trucks in 6 hr. a day can deliver wood into the system from their woodyard to keep the mill operating for 24 hr. Have you people gone into that at all?

MR. DOLLEY: We have consulted with people in the pulp wood industry as far back since the war. In 1945 we met with the American Pulp Wood Association and listened to those gentlemen as to what they found wrong with all type trucks today and what they were looking for. We believe we have built trucks today that are particularly ideally suited for hauling pulp and we stand ready throughout the country to work with any mill in any special problem peculiar to their locality.

MR. MCNALLY: Can we ask you to give some assistance to Mr. McKenzie in the study he is making?

MR. DOLLEY: I would be glad to.

ANON.: Most of the Southern mills get their wood by rail—we get about 50% of our wood in by boxcars.

ANON.: It is a problem to unload boxcars and we are getting so much wood in boxcars it seems to me like a solution to the whole problem is to cooperate with the railroads and get more rack bars—there is no problem at all to unloading a rack car—I do know that the railroads do object sometimes to the overhang problem on rack cars when they operate over a double line track.

ANON.: I would like to know the objection to the open cars handling wood on the railroad's part.

ANON.: It is mainly due to the overhang problem—that little bit of extra length is vital to the clearance on a double line track.

ANON.: That is the point I am getting at—why don't you fellows cut it so it is the right length for railroad cars.

ANON.: They thought they had done that when they cut it 5 ft. 3-in.—then you have to pack it double—10 ft. 6 in.

ANON.: Southern R.R. has now brought out new rack cars just recently and they don't have that triangle divider at each end of the car—the original rack cars I believe have a triangular divider.

ANON.: I think the railroads are getting to that because of newly developed means of unloading a rack car with a rack—a rack operated with a crane or dragline and they just rake the wood off the car. I think all the newer rack cars are built with newer construction inside the end bulkhead.

ANON.: I think the Southern paper mills represent a very high percentage of the total freight service both on raw material and finished material, as far as the railway is concerned. If the paper mills get together, instead of letting the railways . . . .

ANON.: I would like to take issue with that—I can't see this situation of why using boxcars to solve the problem because if they are going to tie up boxcars that they need why don't they make rack cars.

ANON.: That is exactly the point that I make. If it is so much more economical to use rack cars why don't we put the bite on the railroads to get a certain number of rack cars to settle the transportation problem?

ANON.: The trouble is that everyone of these mills since they have been built have increased their capacity every year and the railroads just haven't been able to keep up with them.

ANON.: In general, railroads are not particularly interested to build special type cars as has been indicated by tank cars which are owned by companies which make and rent cars to railroads. Why not get together and design a rack car and form some sort of a mutual agreeable arrangement

where you can get sufficient rack cars and then lease them out to the railroads and, therefore, get some sort of a common pooling?

MR. STOESS: The General American Transportation Corp. in Chicago own and operate the most cars of anybody on the American railroads. They operate tank cars and all types of cars. I think if you can interest those people in a rack car where they would rent them in their shops in Sharon, Pa., or even Chicago and lease them to the paper mills. There might be your answer to your rack car problem. Up in Maine they have built rack cars themselves and they have been furnishing the New England mills with rack cars.

ANON.: As long as you are going to ship by rail you have to unload and load boxcars you have got to load and unload rack cars and everybody seems to be of the opinion that the rack cars are going to be there at the far end of the track in your yard.

ANON.: . . . boxcars of the palet type and have your palets built in from the railroad boxcar itself and have on the floor of the boxcar these transportable type roller conveyors and the logs are brought in individually in the racks and then when they get to the mill you haul off one big palet on the conveyors that are already there out to the door and have the crane pick the whole palet up at a time.

ANON.: I think the investment of that kind would be equal to the investment in a rack car. If you are going to have to fix a box car with a movable palet of that kind you might as well put that money into a rack car.

ANON.: When I talk about bundling of trees—the trees are bundled—15 or 18 logs weigh as much as 50 tons. They are bundled to keep the raft floating.

ANON.: Weyerhaeuser at Everett is using that bundling method. I don't know if they bundle it the same way but they do it.

ANON.: The sinkers are a great problem because they are hauling the logs out of the water at one particular point and whenever you get a lot of sinkers at the unloading area in the water.

ANON.: Would such an idea work—if you banded together a lot of 5 ft. 3 in. sticks, load them and unload them?

ANON.: The railroads are not interested in a one direction load and after all a rack car is only going one way.

ANON.: I think it is a mutual problem of having some sort of an arrangement by which you can handle it.

ANON.: I think we are on the right trail with this. First of all we have a truck representative who will assist us in this study—we are hoping that we will have a representative of the railroads or car manufacturers.

ANON.: The paper mill will lease the car. They will pay so much a month rent for that car. If that car goes back empty from your mill back to your woodlands operation the railroad pays back to the paper mill a certain wheelage amount but the user really gains a little bit by leasing the cars rather than using the cars that are owned by the railroad. You would probably get a preferential freight rate from the railroad.

ANON.: We have started on railroad cars—we have started on trucks and now you have other means of delivering wood to the mill—barges. That is more or less a simple loading and unloading problem.

ANON.: That is one of the biggest handling methods that the Ontario Paper Co. have—that is not a barge that is a shipboard handling.

ANON.: . . . they ship a lot of wood by long distance by boat—they will be able to help you on the unloading problem.

ANON.: They are not our own boats.

ANON.: I think I have seen that operation when I was in Canada. Isn't there one way in which they weigh the wood as it comes out of the water by displacement—very ingenious piece of equipment—two elevators—they run one elevator full and drop it down into a tank of water and measure the elevation of the water in the tank.

ANON.: I would like to ask the people present here whether any of them are in a position to offer us any data or will get some for us on this matter of transporting small sizes of pulp wood to the mill. I recognize it as a minor problem to a lot of people but probably with others it is not so minor. I think our endeavor would be to obtain enough information that we could publish it in a form that would be of value to people who do handle this wood and would like to know what methods are used elsewhere and what their relative cost might be. In case they felt their costs were high they could investigate it and if their costs were higher than the average we show in the particular method we may be able to publish with the operator's permission, of course, it might change their whole line of thinking of operation.

ANON.: Maybe we can be of some service to the industry—maybe we can't—I don't know. If we could obtain the data and publish it in such a way that it would be of interest and of value to the industry we are certainly going to try to do it.

ANON.: I think that every producer's representative here—what is your problem and what is your solution. I think that the best thing that we can do with this—that everbody will be glad to accept your information and forward it on to Mac and let him get it—the two of them work together and get the available data—you don't have to do it today but after all it is for your mutual benefit and we are trying to help you.

ANON.: We have taken on a couple of projects at this conference—one of them is going to be handled by Helverson on unit loading of finished product—the other one is this matter of handling of wood from the forest to the mill yard and I think it should be worked out comparable to a lot of other information that TAPPI has furnished which you all will recognize as being very valuable—at least I do—and if we can get a cross section of industry methods on this particular problem we can probably come up with information that will be of value to everyone.

ANON.: If you would like to participate on the Materials Handling Committee don't hesitate to let us know about it. We want all the available help that we can get on every phase of the paper industry and if you and your company are interested we would more than welcome any of you.

ANON.: Now we have taken on a study of the wood getting to the mill and the finished product getting out of the mill.

ANON.: Give it some thought and if you want to get in on it don't hesitate and I think that unless anybody has something else to say. . . .

ANON.: When you use a vacuum type of system you use air at a vacuum of 11 to 12 in. mercury so that you have a lack of oxygen in your main line. We made some tests at the Hercules Powder Co. with cellulose acetate which is more explosive than starch. The acetate didn't burn. Where the cellulose acetate was coming out from the end of the line we put a gas flame—we got a flame at the end but it did not go back on through the line. They came to the conclusion that cellulose acetate can be handled in the conveyors without the worry of any explosion. They did, however, put explosion vents on their bins in case of an explosion in the bin—starch would be the same thing. They used steel bins.

ANON.: Do you have any experience of the handling of sulphur?

ANON.: We steer clear of sulphur because you have to have an air lock.

ANON.: What was the reason for selecting rubber belts for the wood conveyors?

ANON.: With chain conveyors you get a lot of wear and your chains are expensive. Chain conveyor maintenance costs have gotten to be very high when you get crane loading of the conveyors with the grapples and when they get into capacity conveyors that they now have at these mills—the mills were first started with 250 tons and probably not serious

but when you get the mill up to 1200 tons, the conveyor is loaded and the chain is no longer . . . .

ANON.: There is a general hesitancy on the part of paper mill operators through the States to use belts over chains. I think it is pretty well decided that each has a proper place. There is no argument as to whether a chain is better or a belt is better—each one is in its own place.

ANON.: If there are no cleats on it, it means that you have to have a certain angle because otherwise the wood slips back. You have to try to get your shortest distance that you possibly can—that is one of the things I was interested in in finding out you have a belt with 11°.

ANON.: From Canada the information that we have on logs is 8°—this 11° is a little more—you have got to have an 800 ft. radius.

ANON.: I would like to get back to these pneumatic conveyors—installations in high moisture areas—does it make any difference, loading in high humidity areas?

ANON.: None whatsoever.

Mill Maintenance and Materials

"Use and Maintenance of Steel Windows in Pulp and Paper Mills," by K. S. Frazier (*Tappi* 34, No. 10: 458–461 (Oct., 1951)).

MR. FRAZIER: In one of our conferences I brought up the point that the initial coats of painting would cost as much as the zinc coatings, and since immediately I had a group of hands up to repute the idea we took a poll of the room and we found that 80% of the agents from all over the United States could prove by definite figures that the initial coats of protective paint would cost more, and in the Chicago area quite considerably more, especially if they have had to use scaffolding, then a galvanized unit. It is according to what type of a building you have. For factory buildings or industrial buildings you do not need painting as a decoration in any sense of the word. If it is a decorative scheme people will want a certain amount of decorative painting, and there is where your bonderizing makes it ready for painting immediately.

MR. PARKER: Thank you very kindly, Mr. Frazier, for a very interesting paper. To hurry on I would like to now present H. R. Meyer of the Westinghouse Electric Corp. of East Pittsburgh, who will present the paper on electrical maintenance including electronic equipment.

"Preventative Practices in Electrical Inspection," by H. R. Meyer (*Tappi* 35, No. 1: 132 A–136 A (Jan., 1952)).

MR. PARKER: Thank you very much Mr. Meyer. Gentlemen, I am still going to take a couple of minutes—we are overtime—possibly you have some questions to ask.

ANON.: We have the corn cob cleaning machine at Charleston and it has saved us quite a bit of money as far as maintenance and time. One particularly interesting point that you brought out on electronics was the necessity of having trained men. We are faced at Charleston with trying to train men in electronics, magnetic amplifiers, and what not, and we seem to feel that industry, as a whole, should help some of us pulp and paper maintenance people in trying to train some of our electricians who really don't know anything about it. The engineers go ahead and buy this type of equipment—they install it—the papermaker says it has got to work and make production—they have trouble, and we send a man over and he says "My God, what is that?" We would like to know how to train these people in a place like Charleston.

MR. MEYER: That is an excellent question and one that is always asked when a new product is put on the market and the manufacturer of that product hasn't taken all the steps that should have been taken to help the purchaser's maintenance personnel. My personal feeling is that if you are trying to establish a maintenance group to take care of this type of equipment you should feel free to call on our engineers closest to you for help with your program. If you feel that that is not enough then I suggest that you take the matter up with our nearest district office thus warning the manufacturer of these goods that you don't like it, that you are buying something that you don't know how to maintain and that he doesn't properly tell you. You remember the fellow that wrote the letter about the bicycle—he received a bicycle but couldn't find the saddle and then he put a P.S. at the bottom —as I write this letter I find the saddle in the box. We don't like to give you the information afterward—you really should have it with the equipment.

MR. BOBE: I think Mr. Meyer has covered the way this is handled very well. Usually on equipment involving electronics and other complicated control schemes field engineers from the various manufacturing companies help start the equipment up and at that time they are in a position to instruct the mill personnel in the proper maintenance. We make every effort to try to determine what that proper maintenance should be prior to the starting of the equipment and also while it is being started. We do all we can and we do have the facilities to give whatever training may be required to the mill personnel.

ANON.: I do feel that the manufacturers themselves are lacking tremendously. I do feel that you do bring your service men out, our supervision does get trained, the small amount that we have, but manufacturers as a whole, have not realized the problem that we have in training those men who have for 30 years been using pliers, screw drivers, and all those things. I feel that you should make available some sort of training course whereby we could train our men on these particular types of equipment with which they are not familiar. I think the manufacturing concerns have been very lax in that. They bring a service man up who describes the equipment but that does not do the mechanic any good for he does not see the particular equipment nor does he work with it.

MR. MEYER: I now have something to take home with me —that we are not doing the job which this gentleman and possibly others think we should be doing in helping to train men to maintain the equipment which we produce and you may rest assured that you are going to hear about that through some source.

ANON.: It is true that most electrical or electronic manufacturers do have electronic courses available at practically no charge or at no charge to train the ordinary electrician who has had no experience or training in electronics. I understand that they are put out in a very simple way and I believe that they do a good job in training even though the instructor is not trained himself.

MR. MEYER: In other words, you feel that something has been done to help train these men but that the type of men we have to train are limited in what they can absorb.

ANON.: That is right. In our mill, for instance, we are faced with the same problem. I am giving this course myself to one of the electricians with the idea that I want all of the electricians trained rather than to hire one or more specially trained electronic men and then have two different types of electrical craft in the mill. I think it is the responsibility of the electrician to learn this new field as part of his work.

MR. MEYER: Would you say that your work so far has been successful and do you feel that when you get through with it these men are going to be able to maintain this equipment?

ANON.: Yes, definitely.

MR. MEYER: There we have two opposing theories—it may be that the first gentleman hasn't the information that the second gentleman has and that may be our fault.

MR. OSBORNE (Crossett Paper Mills): We had a similar situation—we bought one of the paper machine drives with electronics and gadgets and things and the electricians just were not able to cope with the vacuum tube. We obtained a

course—there is one available from the General Electric Co. I believe there are others that are available. One of the troubles and the criticism I have of these courses is that they start with Ohm's Law and jump very rapidly into something else. It is that little transition period that we need to fill in. We have a lot of tube testers and one thing and another and we are reasonably proud of our success but it certainly has been of a limited nature. We have possibly two men who have taken enough interest in their work to buy some books and that sort of thing. They will all come to the training courses —we just keep plugging along and tell them to keep their hands off unless they know what they are doing and we make paper.

Mr. Meyer: You feel that due to the fact that Ohm's Law has been with us so long we can almost feel it but beyond that when we jump into the electronic tube we are in another mystery.

Mr. Osborne: Yes—therefore, as part of our electrical engineering I have been assigned to assist the electricians in this transition period. Of course, some men who have been electricians for twenty years haven't fiddled around with Ohm's Law particularly or with tubes. They take the radios at home to a radio man and let him fix them. They understand a contactor, a resistor, they can understand everything except the installation of a simple tube in the circuit, then they are lost. We are gradually overcoming that at our mill, and I think are making heroic steps in that direction.

Mr. Copper (Westinghouse Electric Corp.): All I want to say is that I think there have been quite a few courses put out not only by the company you mentioned but also by our company. I think that right at the end of the war or just before the end of the war there was a very large amount of electronic information put out by most electrical companies. It may have been a little premature because it was put out before it really found its use in the paper industry and that may be the reason some of those courses were not known to everyone in this room.

Anon.: I am sorry I didn't mean to just mention General Electric for we do have a good many of the Westinghouse courses and they are very helpful. We try to get all the help we can. The Government has put out a good many bulletins on rotating magnetic fields and all that sort of thing that seem to help the men very much.

Mr. Parker: We are going to adjourn this Maintenance Meeting to the Tower Room. I do want to thank Mr. Frazier and Mr. Meyer for the effort they put forth.

Mill Maintenance Discussion

Mr. Parker: Mr. Paul Corning of Rayonier is going to act as moderator for this meeting and will start the discussion with a paper that he has prepared.

Mr. Corning: There has been a trend in the pulp and paper mills to regain maintenance and insulation as a necessary evil rather than a means of conserving B.t.u's. This condition has probably been aggravated by drastic increases in material and labor costs. It has been found that some mills have abandoned insulation on many of their lower temperature tanks and equipments and others are resorting to protective coatings that are less expensive but possess very poor insulating values. In view of this trend, the Mill Maintenance and Materials Committee has deemed it advisable to schedule this insulating clinic. The following thoughts have been compiled by the committee to stimulate discussion and promote an interchange of ideas. The ultimate purpose of investing an insulation is to save fuel and to attain the best net saving from this type of an investing, any near or repair insulation project should be well planned. It would appear that there are three phases of a well-engineered insulation installation: (1) Selection of the most suitable type of insulation. (2) Arrangement for a well-designed installation—we can have a discussion on any of the points you gentlemen would like to discuss in detail—good insulation practices—provide for expansion, metals expand more than insulating materials—where temperature is varied over a wide range expansion joints should be provided to take care of the difference in expansion. (3) Insulating cement should always be applied to heated surfaces—those cements will stick in heated areas. (4) Never apply insulating cement in layers over $^1/_2$-in. thickness for application—permit drying between successive layers. (5) Make certain that the insulation fits snugly around the pipe—loose covering increases heat losses and is more easily damaged by impact. (6) Loose insulation on flat or curved surfaces also contributes to increase heat losses and can be more readily damaged by impact. (7) Do not load insulated pipelines in any manner, such as erecting ladders, scaffold, and so forth—even though the covering is not destroyed it may be permanently compressed and thus have an air space structure ruined, materially reducing its efficiency. (8) Replace all covering as carefully as though it were new installation when pipe repairs are made —improperly applied covering cannot do a good insulating job and is more liable to failure. (9) Eliminate or minimize excessive vibration on insulated pipelines and equipment as it may cause joints to open, bindings to cut into insulation to wear the topside of the pipe and otherwise reduce the efficiency of the insulation. (10) Examine all weatherproof surfaces, especially plastic coatings, to be sure that no cracks or openings develop to permit seepage or moisture or process liquor into the insulation. Moisture or process liquors may not only reduce the efficiency of the insulation but may actually react with the insulating material and either permanently reduce their effectiveness or destroy them entirely. The binding wires and fastenings may also be rapidly corroded away permitting total failure of the insulation. Hairline cracks can be damaged. One way to insure continuous weatherproofing film is to spray on one or two coats of good grade asphalt paint about once a year that will seal off the incipient cracks and avoid trouble. Asphalt paints are inexpensive and can be applied quickly by spraying. (11) Wherever possible all large weatherproofed surfaces, such as tanks, should be provided with drains at the bottom of the tank to let any liquor or moisture that collects drain away. These drains may also show a failure of the tank itself before it has progressed so far as to cause total failure of either the insulation or the tank or both. (12) All metal surfaces of tanks and other process equipment should be given a heavy spray coat of a good asphalt paint where the equipment is handling alkalies and possibly a coat of phenol formaldehyde paint where acids are present. The use of recently developed chlorinated rubber base paint will stand both acid and alkalies —while quite expensive it may be indicated. (13) Stop leaks in the steam, hot water, and insulating process lines as quickly as possible. Water or process liquor may follow along the pipeline for a considerable distance saturating the covering and doing unrepairable damage. In most cases the saturated covering can be removed and replaced with new material. (14) Water hammering in steam lines can be caused by inefficient or insufficient insulation. After the cause of the water hammer is removed examine all insulation for damage—the shock of vibration set up may break the tie wires or the insulation causing the joints to open up. All damaged insulation should be repaired as soon as possible. (15) Failure of canvas or other type of jackets into burning or rotting is an indication that either the joints in the insulation have opened up or the jackets are being attacked by chemical fumes in the atmosphere. The cause of the trouble should be determined as quickly as possible. (16) Broken pieces of magnesia covering and blocks can be salvaged by grinding them into a coarse powder which then becomes an insulating cement, however, we must remember that cement when applied will not have the efficiency as the original material—it will be as good as maybe a good cement. (17) Remember that insulating cements are not as efficient as pipe covering blocks—they are used only

for irregular surfaces where it is not practical to use formed material. (18) When applying metal wire over insulation always lap the mesh at least 6 in. and lace securely. This will minimize cracking of the cement finish at the joints. (19) Where spillovers are apt to occur select a design that will offer high resistance to wetting or effected by chemical solutions. (20) Plastic finishes tend to fail where exposed to sun and to weather. (21) Consider use of saturated and coating roof and material jackets as protection for outside piping installations using copper, stainless, or Monel wire.

MR. BURLESON: On the fit of pipes I think that all of you know that steel pipe is not made exactly to dimension. It may have a plus tolerance that may run as high as $^1/_6$ in. so insulation cannot fit perfectly. Of course, it should be made with some tolerance too and a good fit of pipe covering on a pipe is when you get it on it won't rattle on the pipe but you can still slide it back into position—I consider that a very good fit. Another thing that you have to think about is if you are insulating high temperature pipe with superheats that may run from 800 to 900° that pipe expands and if your pipe cover fits it very tightly when it is first put on it won't after the pipe is heated up once. When the pipe expands it will either cause the bands of wire to cut into the covering or it will stretch so after it has been heated up once it will not fit as snugly as when the pipe is cold. Actually, particularly for high temperature pipe, the covering should be just a little bit oversize—not enough to matter but a little bit oversized.

MR. PARKER: One practice that we have adopted was to paint virtually all of our lines white—that is inside the plant. It has had a peculiar effect—if you place anything against that white surface it leaves a mark and tends to destroy its good looks. We have found the men are not so prone to place materials or equipment aginst those white lines and cause a dirty spot. There has been, as naturally can be expected, some amount of educational work done along that line to keep the men from placing materials against or even over the lines and unloading them but the appearance of the white paint which is kept in good condition not only protects the jacket on the insulation but it seems to have a particularly health effect in dissuading men from abusing the material under the jacket.

MR. HEMPHILL: Wayne (Smith) I would like to ask you how successful have you found the aluminum jackets in the rather highly alkaline atmospheres which you are operating.

MR. SMITH: We have found the aluminum jackets highly successful. . . .

ANON.: There are certain places where it is necessary to cover the insulated material with an armored guard—those are points where you have to bring insulation closely to the floor in a congested area where even reasonable care on the part of the employee will not keep the jacket or keep the insulated material underneath free from damage. It is just a sensible precautionary method which anybody would take where you have a highly dangerious spot from traffic or such condition as that.

MR. PARKER: Are there any other suggestions as to methods for protecting insulation? It was quite interesting to hear your comment pertaining to the aluminum jacket because I have heard of instances, particularly in kraft mills, where there has been serious corrosion of aluminum.

MR. SMITH: Our aluminum installation throughout the mill is relatively new—so the information we are putting out may be premature although we noticed over a period of years we had several aluminum transmission lines in our plant and apparently they withstood the corrosion of the atmosphere beautifully—in fact one of them was continually bathed in the exhaust from our recovery units. Apparently what happens to it in that atmosphere is that it forms an oxide on the surface —it gets dull and doesn't look too attractive but the film itself apparently protects it from deterioration.

MR. TEEPLE: On this matter of corrosion of aluminum pipe coverings I think that you people are right in worrying about possible corrosion in an alkaline atmosphere but I think that Wayne's point is well taken in that as far as atmospheric corrosion is concerned you do get some slight, visible buildup of an aluminum oxide film and that does tend to be protective. Even in an alkaline atmosphere the aluminum doesn't perform too badly considering the job that it is doing. However, it would not be satisfactory, for example, if you had a line in an alkaline part of your mill where condensate was forming on the aluminum and, consequently the caustic fumes in the air were continually being dissolved in this liquid condensate in contact with the aluminum. Under those circumstances, I think the service life would be relatively short. Where the atmosphere is such or the humidity is such that you don't run into condensate, in other words, the aluminum shielding remains dry I think it is probably a pretty good bet. You certainly get a lot of square feet for a dollar so to speak.

MR. PARKER: Are there any further comments pertaining to covering or protection of insulation?

MR. BURLESON: Before I say anything about the asbestos I would like to make one comment along that plastic finish point that was brought out and that is I don't believe that the spray coat of asphalt paint once a year or so will help the cracks you get in a plastic finish. The reason I say that is that the plastic finish doesn't just crack—it is cracked by movement of the vessel on which the insulation is placed—that movement can be caused by expansion or contraction or it can be caused by the vessel stretching when it is loaded or pressure is put on the vessel. The insulation is actually cracking by movement of the vessel or the finish is and you will continue to have movement after that cracks whether you cover it up with paint or what you cover it up with and it is only a question of a very short time until the volatile dries out your paint and your crack is there again. That feature of the plastic finishes is the reason we have worked out this asbestos system of weatherproofing or waterproofing insulation on tanks and vessels—it is to overcome that movement that is inherent with practically all heat equipment. The interesting thing about this problem is that I think for years we have been trying to waterproof insulation by a hard and unsatisfactory method when there has been quite an easy one that could be used and is quite adaptable. For years we put blocks, blankets, or something on the vessel, we tie them on with wire or other light metal fastenings of some kind and then a man comes along with a trowel and by hand he trowels on a coat of asbestos fiber and portland cement and then over that you stretch netting or something else, and he finally comes back with his hand trowel and he puts on a coat of mastic of some kind—strictly a hand operation. That does just what I have said—you have put a hard shell that is weak—it is absolutely nonresilient and it is inelastic around something that inherently is moving most of the time so what happens—it cracks and can't help but crack. At the same time I think there is a well-known way of doing that—you know you can't question much when a man say's his roof leaks—we have trouble with roofs—all kinds of roofs leak from time to time but you would think it was funny if a man came in and said the walls on my house leak. We have found out several hundred years ago how to build a wall—build a house so that it doesn't leak—we have leaks around window heads and door heads and just the wall itself nobody has any trouble with the wall of the house leaking but they do. They put up some studs and then they nail siding on it or they nail shingles on it. Why in the business of insulating tanks and vessels shouldn't we take a cue from this—why not put studs on the sides of your tank, digester or whatever you have and then put shingles on it and that is what we have done with our system of weatherproofing tanks, vessels, or any vertical, cylindrical surface. We can do it today a darn sight better than the people who moved here two hundred years ago did it because we have much better material. Certainly we wouldn't put 2 by 4 yellow pine studs on the side of the vessel and we

wouldn't put redwood siding or some other kind of siding on it so what we do with out specifications is use 4 by 8 ft. asbestos cement sheets in big units. I think you are probably all familiar with asbestos cement sheets—our sheets are called asbestosite and they have certain properties which make them ideally suited to this method of weatherproofing attack. These sheets are completely weatherproofed and they have excellent corrosion resistance. I won't say they will resist forever all of the acids or alkalies or what not that you have around the paper mill but they do have good corrosion resistance. They are flexible—these sheets can be bent to a diameter of 10 ft, they have excellent workability, you can drill holes in them, you can shear them, you can drive a nail through, you can saw them—they have very nice workability, and finally they are completely incombustible so that the finish on the tank will not support combustion in any way, and it is virtually fireproof. We make a tank like that—we mount these tanks on studs—they are shingled over each other just as you do the siding on your house. They are free to move with the vessel and if they move 1/4 or 3/8 in. the vessels are still waterproof just as the shingles on a roof are—the house can move all around but the roof is still waterproof. Now we need studs—as I said we wouldn't use 2 by 4 studs so we take steel or if you have a corrosive condition where you require something better than that, steel alloys and make our studs of that. They are structurally strong, they are easy to work, and in normal times, they are quite readily available and easy to fasten too. Our fastenings are self-tapping screws and they certainly make a positive fastening. Incidentally, when we use this house wall construction I suggest that you don't get the idea that you can put this thing up and then blow house insulation into it because it won't work. Somebody thought of that three or four years ago—they tried it—the tank worked and worked and worked and the wool nodules keep going down and pretty soon they developed so much pressure in that they burst the structure loose. Of course, long before that happens you got 1, 2, or 3 ft. of void space up at the top. One feature of this system is that the insulation is back about a 1/4 in. behind the outer surface of the stud that provides an air space between your asbestos site weatherproofing and the insulation. That has a very definite purpose. When we designed this system we designed one which we think is absolutely weatherproof but we also took into consideration the fact that there may be flashing that leaks, there may be an accident and water or some corrosive material may get in behind that weatherproofing. With this air space provision is made for any moisture to evaporate rapidly from the insulation. We have a system of mounting studs on the tank which thermally insulated from the tank. This is the clip of fitting that we use against the tank and this fitting can be fastened to the tank with steel strapping. If you can weld to the tanks there are holes so that the clip can quickly be put on with a Nelson plug or if you don't want to use a Nelson drill you can simply tack weld it along the edge. Before you put it on the tank a block of material called marine sheathing is fastened to the bracket with self-tapping screws, you pre-drill it and fasten it with metal screws. It has excellent holding power and it has quite a low conductivity so, in effect, your outside surface is thermally insulated from the tank itself—there is no through metal contact at all. Your stud is screwed in through from the other side. The reason for a groove down the middle of the stud is so you can get all of your screws in there and the heads will be below the surface of your asbestos patch. An insulation support angle at the bottom of the tank is important—there must be a support for the insulation. With an outdoor tank that is on the ground the support should be high enough above grade so that under extremely wet conditions as when you have a heavy rain storm the water level will not come up to the insulation.

Mr. Smith: In your talk and in your pictures I do not catch on as to how you put the top on to the tank—your tank there was a flat top tank but assuming that you have a dome tank how would you put your covering on the top and take care of the joints at the side?

Mr. Burleson: We don't have any method of applying asbestosite to the top of a tank. On the tank that you saw in the pictures we didn't put asbestosite on the roof of that tank. I would not recommend that anybody attempt to make a roof out of asbestosite. What we recommend on most roofs is what we call our three course system. Three course system is kind of a fancy term for a very simple thing—it consists of, first of all, a hard surface because somebody is going to walk on that top sometime. That means blocks and a cement finish of some kind—then on top of that we trowel on a cut back mastic—in our company we call it air tight but there are lots of them—and in that mastic we lay a 15-lb. asbestos felt—regular roofing felt. It should be back nailed into the cement finish when it is applied, and we trowel more of this airtight coating on there and lay felt on it. In other words what it is is a cold application build-up roof but rather than being a two-ply roof or a three-ply roof it is a one-ply roof except where the one felt laps the one before it—we lap them about 3 in.—just enough to cover up the back nails and then trowel more of this cut back mastic over the entire surface. First of all we use a cut back mastic because if you seal it up tight enough the asphalt will still be rather ductile and almost tacky underneath for quite a long time. A cut back mastic, if you have ever watched one dry in a few hours, will get a skin on top of it and as soon as that skin forms then down underneath it stays tacky or at least ductile for quite a long time. That is the reason we choose that type of mastic—your roofing felt is put in as a reinforcing agent so that, unless you do get excessive cracking, the roof felt will bridge the crack and hold it together. The second coat covers up the felt and gives you a fibrous coat for exposure to the weather and gives a finish that isn't only weatherproof but is also vaporproof. I know that for some of your equipment, digesters, at least in one plant it worked out where they actually put a great big stainless steel flashing on top of it—the stainless steel went out and flashed down over the asbestosite side.

Anon.: I think I built the first of those transite cases that was ever built up Kings County Refining Co. at Farmers Valley, N. Y., a couple of weeks ago. We used it over the insulation instead of using this construction. I notice that you have an air space between your insulation and it would be very desirable if once your equipment gets up to temperature it would always stay that way but somehow it never does. I was just wondering how long those supporting wires were going to hold up the insulation?

Mr. Burleson: That depends on your supporting wires—if you have a wet corrosive condition around the tank you should use stainless steel studs and stainless steel or Monel wires. I think the entire oil industry is getting to the point where they use nothing but stainless steel fastenings on any of their insulations. That is a case where a little judgment is required too. There are some areas and tanks where you don't have to worry about that all—for instance, a refinery in Salt Lake City or a refinery in Texas—the relative humidity most of the time may be 15% or 10% and it doesn't rain very often. The tank is heated probably 300 days out of the year, or maybe 330 days, so they have no worries—they wouldn't have any corrosion of their fittings anyway. In New Jersey where your relative humidity, and I imagine it is the same right here, maybe 80% a good part of the time during certain months and if your equipment is going to be down then you will not only have the matter of leakage to think about but you have the matter of condensation that takes place during certain times of day. If you have those severe conditions on equipment that is operating intermittently certainly you should use non-corrosive fastenings of some kind.

Mr. Corning: There is a suggestion that all large waterproofed surfaces, such as tanks, be provided with drains as well as to indicate any possible failure of the tank. I have discussed this with members of the committee and probably

the most practical suggestion would be to use a stainless steel nipple possibly 1 to 1 1/2 in., in diameter and after the insulation has been placed on the tank several holes be drilled—the stainless nipple covered with asphalt and pressed into the opening. I don't know whether you gentlemen would have any different technique which you would like to bring on the floor for discussion. It seems to be an excellent suggestion because it is not only the matter of protecting the insulation of the tank itself but it will be a tell-tale on any failure that will occur to the tank itself. All metal surfaces of tanks and other pieces of equipment should be given a heavy coat of good quality asphalt paint where the equipment is handling alkalies and possibly a coat of phenolformaldehyde-base paint where acids are present.

ANON.: You might look into these so-called resin paints—some of them have excellent acid resistance and also have high temperature resistance.

MR. CORNING: At this point I would like to call on Mr. Brown in connection with wires and Inconel, Monel fastenings to give us a little information on the latest developments.

MR. BROWN: Our recommendation for wiring for this application would be Monel. Monel would have the high stress and the corrosion resistance needed for this type of application. Also, of course, Inconel which is another one of our products, but because of the low cost the diameter of this wire is generally about 0.032 and we believe that Monel would be the most suitable type of wire. It is now produced 48 in. wide and 300 ft. long with 1-in. centers and we also make the conventional brass inseal.

MR. CORNING: During the discussion I heard it mentioned that there was a definite advantage of Monel and Inconel wire instead of stainless because of their physical properties.

MR. BROWN: In atmospheric corrosion conditions we have found that Monel has given better corrosion life and also given a longer life. The main feature between type 304 stainless and Monel is that in this type of diameter Monel is cheaper.

MR. HEMPHILL: I think the point we were trying to make was that the stainless steels are much stiffer and much harder to work and so do not go on nearly so fast. With labor as it is the Monel, in our operations, goes up faster and ties easier. It forms a quicker tie—the mechanic gets the technique of tieing with just a twist and if he has to let the wire jump away from him or if it does get away from him—it gets out of his hands and he has got to fiddle around with it he gets all irratated and the bosses get on his neck too. Is it true that the Monels are softer, more easily handled?

MR. BROWN: Monel is much softer to work, and the main feature is that stainless steel has a tendency to work hard and you have a much easier time in working Monel. We have been working, which is pretty generally known, with the use of Inconel on fourdrinier wires—this is a little off but it is a very similar type application—Inconel will work harden but not as readily as stainless steel.

MR. SMITH: To develop just a little further I wonder if Mr. Brown could give us a rough comparison between type 304 stainless and Monel.

MR. BROWN: I think John Nation of J. M. Tull would be a better fellow for price.

MR. NATION: I can't give you an exact comparison in price but you will find that stainless steel wire is so much harder to work as you go to 0.032 or lower that stainless steel wire will be at least 50% higher than the cost of Monel. I want to correct one thing that you said, if I may, the reason Monel is so easy to work—we control the temper and give them a soft wire but I don't want to leave the impression that we can't furnish a Monel metal wire that is also very hard.

MR. WEILER: On a recent job in Philadelphia where the customer wanted what he called stainless we found that the cost of that wire 1-in. mesh was about 16 1/2¢ a sq. ft. in rolls—16,000 sq. ft. in one operation—against what the customer had always been using, galvanized wire 1 in. mesh, 2¢ a sq. ft. The only reason that we could see for using the stainless steel wire was the fact that over the normal construction is the block form of insulation, chicken wire, and asbestos cement. We asked him if we could omit the asbestos cement and change from an emulsion to a cut back because, if you stop to consider, you are putting on a highly porous material—a coating of asbestos cement or other finishing cement which will normally contain from 10 to 15 lb. of water before it is workable. In other words, the mechanic in mixing up his finishing cement normally will dump a bag of cement in a mixing box and pour water on it until it comes over the top of the box, let set overnight and the next morning it is pretty wet. Trying to check the weight of that as nearly as I could get it, it was at least 10 lb. per sq. ft. In some cases it would run up to 15 lb. per sq. ft. of water that you are adding to a highly porous material—your insulation blocks and over that you are stretching another layer of chicken wire and normally putting on an emulsion which is 50% water. I would like to offer for your consideration a cut back mastic which has no water, which will permit the use of the galvanized chicken wire at a considerable reduction in cost. By spraying it directly to the first layer of chicken wire you add no water to the insulation and at the same time you provide an excellent protection to that chicken wire which will either break or retard if not entirely eliminate the rusting which is started when you put your asbestos cement on. Observation of many thousands of feet of failed coating over insulation indicates that the water that has been in the finishing coat will invariabley settle out and cause rusting in the twist in the chicken wire. Therefore, if you eliminate the addition of that water which is there to start the rusting—the only thing left to start the rusting is from your insulation blocks which have picked up some percentage of moisture between the drying oven and the day of application. As the equipment approaches operating temperature that moisture is driven away from the hot side—it goes out somewhere in the insulation—some of it will come off in the form of moisture vapor—the balance will settle in the insulation where the temperature is less than the 212°, your vapor point for the water. As your equipment stabilizes or the temperature stabilizes you have driven off as much moisture as you can and the rest of it is stabilized somewhere possibly in the outside 1/4 or 1/2 in. and will probably never be driven off unless you get your equipment away above the temperature at which it was designed to operate. I am merely offering this as something for your consideration. I have used a lot of insulating cement in the past and now I am wondering why we did in view of the amount of water that we were adding to a highly absorbent material.

MR. CORNING: At this point I would like to make a comment pertaining to canvas jackets. In talking with a member of the committee it is recommended that the most economical practice is not to use canvas jackets except primarily for appearance—internal steam lines where you are particularly desirous of having a fine looking installation. Another point that I might make at this time is I have learned that the sewing of canvas covers is obsolete. Adhesives have been developed that will quickly and satisfactorily secure a canvas cover without the tedious and expensive labor of sewing. Suggestion 18—when applying metal wire over insulation always lap the mesh at least 6 in. and lace securely. This will minimize cracking of the cement finish at the joints.

MR. WEILER: I was just questioning the advisability of lapping the chicken wire before the application of cement because if you have one layer looped with some space between the selvedge edge along the side of the cement, if you use it, will barge through and will give you some reinforcement. If you have the chicken wire in two layers then you will have the tendency for both to be kicking in opposite directions.

MR. BURLESON: The reason for lapping the chicken wire is to eliminate a line along which the cement may crack when your vessel expands—in other words, you have a weak line

where that wire will pull apart if your vessel expands. We have noted some cases where the cement cracks along the joint between your two layers of chicken wire. One other thing I might mention is that we recommend that the chicken wire be tied rather than laced. If you lace the chicken wire and have a little play you have a long strip that will loosen up —if it is tied and you have a failure you have only got 5, 6, or 7 in. of it that loosens up.

MR. CORNING: Suggestion 20—plastic finishes tend to fail where exposed to sun and to weather. Would you care to discuss it and steps to avoid it?

ANON.: I think that most plastic finishes do not fail as direct result of the sun and weather. I think they fail as indirect result of the sun and weather. The cause of failure is cracks coming in the mastic finish and water getting behind it. Any good plastic, if it didn't crack, should stand the effects of the sun and weather for a great many years. It all has some type of fibrous filler in it which, as soon as the asphalt is eroded or weathered away, the filler comes to the top just as it does in an asbestos roofing felt and it should last a long time. The only thing that happens to it is that moisture begins to get behind it.

MR. CORNING: The last suggestion, 21, is the use of saturated and coated roofing material jackets as protection for outside piping insulations using copper, stainless, or Monel wires.

ANON.: I would like to repeat an experience that one plant had. Many of the plants represented here today have their operations here in the South where frost is not a serious consideration. However, one plant that I visited about 800 miles North of here was having considerable difficulty because during a long cold winter spell water and even ice were forming in the roofing jacket, breaking it loose. Of course, the magnesia was getting all soaked and of no value. There was a very definite increase in their condensate lines during the winter and they are investigating other ways of coating those outside lines than using the roofing. I don't know whether that is a factor in your operations in the paper mills or not.

ANON.: I have a comment to make. It doesn't particularly have to do with the maintenance of insulations—it is an observation that I had occasion to check on the other day and may have some bearing on the use of chicken wire under the coatings. I have noticed a great many failures of stucco houses after the stucco fell off after 10, 12, or 15 years. Some of that stucco had been over wire, some of it had been over wooden laps, some over metal laps but, in every instance, the bonding of the material had failed and allowed the stucco coating to fall off. I knew of a particular building that was built 40 years ago that was stucco. I was curious as to the condition of that building and found an opportunity about two weeks ago to look at it. That building was as good two weeks ago as it was the day it was built. The stucco had been applied to rough cement blocks. If we can find some way to keep metal fastenings from under these coatings I suspect we will go a long way to solving some of our difficulties in maintaining the covers on large vessels.

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UNITED STATES PATENTS ON PAPERMAKING

Second Quarter, 1952

Compiled by CLARENCE J. WEST

THE following list of United States patents has been compiled from the current numbers of the Official Gazette of the United States Patent Office. Because, as a rule, only one claim is published in the Gazette, it is not claimed that the list is complete; also, it is possible that the list may contain some patents that do not apply specifically to pulp and paper manufacture.

Copies of any of the following patents can be obtained from the United States Patent Office, Washington 25, D. C., by sending twenty-five cents for each patent desired.

April 1, 1952

2,590,857. Photographic carbon tissue. John F. Hansman and Melvin J. Jurisch, Chicago, Ill. (Hansman assignor to Jurisch). Filed Sept. 10. 1945. 11 claims. (Cl. 101-128.3.) An opaque paper is coated with an unsensitized water-soluble colloid over which is a thin porous film of cellulose nitrate and glycerol.

2,590,905. Apparatus for concentrating residual pulp liquor by direct contact with flue gases. George H. Tomlinson and Joseph N. Swartz, assignors to Canada Paper Co., Montreal, Canada. Filed Oct. 15, 1947. 5 claims. (Cl. 159-4.) A cyclone evaporator is adapted for the concentration of kraft black liquor by direct contact with the flue gases resulting from the combustion of the concentrated black liquor.

2,591,069. Method of continuously digesting and drying flax straw. Edwin T. Hodge, Portland, Ore. Filed Aug. 31, 1945. 2 claims. (Cl. 92-10.) Flax straw is treated with boiling water under suitable conditions, by means of which the fiber bundles are liberated. 2,591,106. Process of making paper pulps. Daniel M. Sutherland, assignor to Lionel M. Sutherland and Douglas G. Sutherland, trustees. Filed July 24, 1947. 5 claims. (Cl. 92-13.) Chips are digested with an alkaline liquor at 340°F. and 110 p.s.i. to soften them, the partially cooked chips are diluted with a hot alkaline wash liquor at 160–180°F., the product is refined at 180–210°F., and washed while hot.

2,591,135. Packet making machine. John W. Chalmers and Donald R. Patrick, assignors to Molins Machine Co., Ltd., London, England. Filed June 17, 1946. 9 claims. (Cl. 93-50.) The machine is designed for adhesively securing the overlapping portions of a cardboard packet.

2,591,188. Apparatus for recovering the inorganic content of concentrated waste liquor. Nils E. Nilsson, Vaggeryd, Sweden. Filed July 5, 1947. 2 claims. (Cl. 23-277.) Partially concentrated liquor, together with primary air, is introduced through an injector nozzle, in the form of a cloud or spray of fine particles, into a combustion chamber. The evaporated material accumulates on a grating where it is reduced by the carbon present. The combustion gases are burned with secondary air introduced through a second set of stationary nozzles.

2,591,276. Display container. Carl W. Middleton, Larchmont, and Earl F. Middleton, New Rochelle, N. Y. Filed Feb. 18, 1947. 4 claims. (Cl. 206-45.34.) The container consists of a cardboard base and end walls and a curved cover of cellulose acetate sheeting.

2,591,368. Water- and flameproofing composition. James F. McCarthy, Mars, Pa., assignor to Treesdale Laboratories and Textile Processing Co. Filed Jan. 22, 1947. 1 claim. (Cl. 260-17.) The agent consists of polyvinyl chloride, antimony oxide, sodium carboxymethylcellulose, and ammonium hydroxide.

2,591,425. Tiltable display carton. Reynolds Guyer, assignor to Waldorf Paper Products Co., St. Paul, Minn. Filed May 19, 1948. 5 claims. (Cl. 206-45.27.) The carton is provided with supporting legs mounted on the rear wall.

2,591,446. Egg carton. James W. Lennon, assignor to Shellmar Products Corp., Chicago, Ill. Filed Dec. 12, 1947. 4 claims. (Cl. 229-2.5.) A molded pulp egg carton consists of a bottom section including a series of egg-receiving cells and a top section consiting of a pan-shaped member having a flat upper surface.

2,591,471. Molded pulp container. Walter J. Schwertfeger, assignor to Keyes Fibre Co., Waterville, Me. Filed Sept. 16, 1950. 4 claims. (Cl. 229-45.) A molded pulp egg carton is formed with two rows of egg-receiving cups, six cups in a row; the rows are separated by a hollow longitudinal division wall and the cups in each row are separated by hollow transverse division walls.

2,591,500. Collapsible cardboard container. Harrison C. Bloomer, assignor to Bloomer Bros. Co., Newark, N. Y. Filed July 16, 1948. 2 claims. (Cl. 229-31.) An integral collapsible carton for foods and other articles embodies means for interlocking its parts when in the erected position.

2,591,548. Cellular cushioned container. William H. Inman, assignor to Bloomer Bros. Co., Newark, N. Y. Filed June 2, 1947. 5 claims. (Cl. 229-28.) A cardboard container for food products embodies a number of cellular compartments which are protected by cushioning walls, as well as means for locking the parts in an erected position.

2,591,578. Insulated container. Raymond W. McNealy and Jacob A. Glassman, Chicago, Ill. Filed Dec. 20, 1947. 2 claims. (Cl. 229-14.) A double-wall paper container for hot or cold beverages.

2,591,593. Handle for carton carriers. Lester S. Nolan, Pittsburgh, Pa. Filed July 13, 1949. 2 claims. (Cl. 229-52.) A 12-compartment container for beverage bottles has a handle which is a portion of a partition.

2,591,629. Duplex divisible carton. Richard O. Spalding, assignor to Owens-Illinois Glass Co., Toledo, Ohio. Filed July 16, 1949. 7 claims. (Cl. 229-15.) A duplex carton consists of two units, each holding 12 bottles, which can be divided into two cartons by the distributor.

2,591,633. Beating apparatus. Erik Stephansen, assignor to Otto Imset, Oslo, Norway. Filed Dec. 9, 1947. 1 claim. (Cl. 92-27.) A beater consists of a roller and a casing which rotate in the same direction but independently. Their rotational speeds can be adjusted separately to obtain the desired relative peripheral speed.

April 8, 1952

2,591,703. Package construction. Karl H. Keller, assignor to The Miller Co., Meriden, Conn. Filed April 13, 1950. 6 claims. (Cl. 206-65.) A shipping container for fluorescent lighting fixtures incorporates a steel strapping for anchoring the fixture to an inner wall of the container.

2,591,751. Whirling roughing and finishing cutterhead machine for debarking logs and the like. William R. Whitlock, assignor of one third to Clark W. Adams, Aberdeen, Wash. Filed Aug. 4, 1948. 14 claims. (Cl. 144-208.) A whirling cutterhead machine is designed for barking logs of any taper and of different sizes without altering the taper or decreasing the size of the log below the bark.

2,591,812. Carton for making ice-cream sandwiches. Porter I. Henderson, Charlotte, N. C. Filed Jan. 7, 1950. 2 claims. (Cl. 229-6.) A carton for an ice-cream sandwich consists of a rectangular sleeve and a U-shaped slide member which is adapted to hold the sandwich within the sleeve.

2,591,882. Wrapper or container of cardboard or like material. Frederick J. Shirley, London, England. Filed Oct. 28, 1949. 6 claims. (Cl. 229-40.) A container suitable for a book wrap.

2,591,885. Purification of tall oil pitch. Roscoe S. Smith, assignor to West Virginia Pulp & Paper Co., New York, N. Y. Filed Aug. 25, 1949. 4 claims. (Cl. 260-97.7.) A mixture of tall oil pitch and dilute sodium hydroxide is held near the boiling point until an upper oily layer separates; this layer consists largely of fatty acid esters of alcohols originally present in the pitch; the aqueous layer contains fatty acid soaps.

2,592,054. Barking drum. Fred A. Mertz and Robert S. Walker, assignors to Traylor Engineering & Manufacturing Co., Allentown, Pa. Filed Oct. 3, 1950. 4 claims. (Cl. 144-208.) A barking drum consists of a continuous cylindrical shell provided with milled bark-removal ports, each of which is reinforced by a bar fixed externally to the shell but suitably spaced therefrom.

2,592,080. Method of molding dishlike articles. Howard H. Thompson, assignor to Weavewood, Inc., Minneapolis, Minn. Filed June 6, 1947. 4 claims. (Cl. 154-83.) A method of laminating a resin-impregnated, creped kraft paper and an impregnated interwoven mat of wood veneer strips.

2,592,081. Method of making containers. Harry A. Toulmin, Jr., assignor to The Commonwealth Engineering Co. of Ohio, Dayton, Ohio. Filed March 26, 1949. 4 claims. (Cl.

93-35.) A gas-impregnated rubber latex is vulcanized and integrally united to a paper bag or container.

2,592,090. Paper winding and smoothing device. Allen E. Weaver, assignor of one half to Hammond Bag & Paper Co., Wellsburg, W. Va. Filed Aug. 30, 1946. 3 claims. (Cl. 242-76.) A paper winder. incorporates means for crowning a traveling paper web just as it goes into a roll, thus eliminating any tendency of the web to wrinkle.

2,592,112. Apparatus for cellulose processing. William H. Bradshaw and William R. Schmitz, Jr., assignors to E. I. du Pont de Nemours & Co., Wilmington, Del. Filed Dec. 6, 1947. 4 claims. (Cl 23-260.) An apparatus for the continuous production of alkali cellulose of uniform composition.

2,592,215. Apparatus for subjecting materials to a disintegrating or pulping treatment. Kurt Wandel, Honey Brook, Pa. Filed July 4, 1945. 8 claims. (Cl. 92-3.) A method for defiberizing wastepaper.

2,592,300. Method of removing hemicelluloses from wood pulp. Jack McK. Limerich, Bathurst, New Brunswick, Canada. Filed Sept. 10, 1946. 4 claims. (Cl. 92-16.) A multistage continuous process for the purification of wood pulp which yields 80% of a product containing 96% alpha-cellulose consists of a series of treatments with gradually increasing concentrations of an alkaline liquor.

2,592,355. Process for manufacturing macromolecular cellulose fiber. Shozo Tachikawa, Kyoto, Japan. Filed Feb. 20, 1950. 3 claims. (Cl. 18-54.) In the manufacture of alkali cellulose, cotton linters with a degree of polymerization of 1460 is steeped in 13.2% sodium hydroxide for 20 minutes at 15° and 10 mm. of vacuum and for 60 minutes under a pressure of 15 atmospheres and compressed in a steeping press.

2,592,470. Machine for manufacturing fiberboards. Nils Ryberg, Stockholm, Sweden. Filed Aug. 31, 1948. 8 claims. (Cl. 154-1.) A machine is described for the manufacture of structural board from straw or other long-fibered vegetable material.

2,592,481. Fiber beater for the liberation of cellulose fibers. Arthur M. Spencer, Santa Fe, N. Mex., Abner Jacobson, Cleveland, and Karl Sixt, East Cleveland, Ohio. Filed June 18, 1948. 3 claims. (Cl. 92-22.) A beater is described in which there are exerted a flexible whipping action and a turbulent throwing effect on softened fiber bundles suspended in a liquid against a series of irregular baffles and walls.

2,592,518. Apparatus for making fibrous cement sheet material. Alessandro Magnani, Broni, Italy. Filed Nov. 27, 1940. 4 claims. (Cl. 92-54.) An aqueous fibrous cement material is deposited upon a traveling pervious belt in contact with a moving suction support.

April 15, 1952

2,592,550. Flexible pressure-sensitive adhesive products. Edward W. Engel, Etzio J. Giolito, James A. McGarry, Vlon N. Morris, and Charles L. Weidner, assignors to Industrial Tape Corp., New Brunswick, N. J. Filed Oct. 6, 1949.7 claims. (Cl. 117-122.) A paper is impregnated with a mixture of a butadiene-acrylonitrile copolymer and a butadiene-styrene copolymer and the dried sheet is coated with an adhesive containing rubber, hydrogenated rosin, calcium silicate, and mineral oil.

2,592,594. Method of and machine for treating fibrous or cellulosic material. Peter N. Ottersland, Napoleon Rigabar, and Edward S. Lansing, assignors to Taylor Refiner Co., Inc., Watertown, N. Y. Filed Oct. 27, 1948. 4 claims. (Cl. 241-28.) Pulp is subjected to a crushing action in the nip of a rotary abrasive roll and a rotary feeding roll; thus the fibers are rubbed or crushed against each other.

2,592,822. Sheet feeder mechanism. Earl J. Rapp and Harold R. Coon, Sr., assignors to Lynch Package Machinery Corp., Toledo, Ohio. Filed May 27, 1946. 6 claims. (Cl. 271-10.) A sheet feeding mechanism for paper and the like incorporates free-wheeling picker rolls.

2,592,880. Machine for erecting collapsed cartons. Joseph V. Ferraro, assignor to Empire Box Corp., Garfield, N. J. Filed Sept. 17, 1947. 24 claims. (Cl. 93-37.) A machine for opening and erecting partitioned egg cartons.

2,592,907. Cooking liquor treatment. James M. Kahn, assignor to Infilco, Inc., Chicago, Ill. Filed March 8, 1949. 5 claims. (Cl. 252-183.) White liquor is centrifuged and the turbid filtrate is treated with a magnesium salt to coagulate it and provide a precipitate which is readily removable from the purified liquor.

2,592,983. Apparatus for separating cooking liquor from pulp. Paul G. van Hildebrandt, Portland, Ore. Filed July 17, 1947. 12 claims. (Cl. 92-7.) A blow pit assembly is described in which the cooking liquor is separated from the pulp by the passage of steam through the pulp, thereby maintaining the resins and lignins in a fluid condition.

2,593,010. Asbestos roofing felt and method of manufacture. George W. Clarvoe, assignor to Johns-Manville Corp., New York, N. Y. Filed Dec. 4, 1948. 9 claims. (Cl. 154-121.) The felt comprises a base sheet of bitumen-saturated fiber felt and a top surface sheet of white asbestos paper combined by bituminous adhesives.

2,593,019. Paper container with dispensing and filling openings for liquids. Rudolf F. Glaser, assignor to Owens-Illinois Glass Co., Toledo, Ohio. Filed March 28, 1947. 4 claims. (Cl. 229-17.) A paper milk container is provided with a sanitary pour opening and lip.

2,593,074. Machine for the coating of webs of material. Arthur R. Trist, St. Catherines, Ontario, Canada. Filed Nov. 25, 1949. 7 claims. (Cl. 118-409.) A coating machine comprises a resilient moving bed which supports a web of material, a fountain for the coating composition which has a floor at its lower part to form a stock for a stationary elastic trailing blade for controlling the application of the composition, and dikes for limiting the width of the foundation for the coating composition.

2,593,092. Partition structure and method of making it. Frank D. Bergstein, Wyoming, Ohio. Filed May 12, 1948. 1 claim. (Cl. 93-1.) In a divider or partition structure for cartons the main and cross ribs are of double thickness, thus providing a cushioning effect for fragile articles.

2,593,135. Bottle carrier. Clyde L. Gilbert, assignor to Owens-Illinois Glass Co., Toledo, Ohio. Filed June 2, 1948. 4 claims. (Cl. 229-28.) The carrier is designed for use with automatic loading machinery; it has a metal or plastic bail-type handle.

2,593,143. Display carton and box. Walter T. S. Hendrick, assignor to J. Lyons & Co., London, England. Filed March 22, 1950. 2 claims. (Cl. 206-45.31.) A display box for candy.

2,593,146. Laminated paper containing activated carbon. Fred Howard, assignor to Sutcliffe, Speakman & Co., Ltd., Leigh, England. Filed Nov. 26, 1946. 3 claims. (Cl. 154-50.) A laminated paper sheet for packaging butter consists of an outer layer of impervious paper and an inner layer of absorbent paper which is impregnated with finely divided activated carbon and a wet-strength resin.

2,593,149. Apparatus for embossing paper. Paul R. Illner, assignor the The Champion Paper and Fibre Co., Hamilton, Ohio. Filed Oct. 17, 1946. 2 claims. (Cl. 101-23.) An embossing calender consists of an engraved steel embossing roll and a cooperating, yielding-surface, compressed paper embossing roll.

2,593,173. Process of refining chemical pulp. Turma Norta and Yrjö Sivola, assignors to Enso-Gutzeit Osakeyhtiö, Helsinki, Finland. Filed July 31, 1947. 5 claims. (Cl. 8-105.) Pulp is chlorinated at room temperature and then heated as a 1 to 15% aqueous suspension at approximately 40°C. for 10 to 200 minutes at a pH less than 5.

2,593,202. Apparatus for screening a suspension of solid material in a liquid. Harry F. Schenk, Sterling, Mass. Filed Jan. 24, 1947. 2 claims. (Cl. 92-26.) A rotary pulp screen has a drive mechanism which is self-lubricating while in operation and which functions during the relative oscillation of the screen.

2,593,328. Perforated multiple ply bag. John W. Meaker, New York, N. Y. Filed July 13, 1948. 4 claims. (Cl. 229-55.) A multi-ply paper bag is constructed of air-impervious sheet material which has been electrically perforated to permit entrapped air to escape as the bag is being filled.

2,593,333. Display container. Harold L. Myers, Morristown, N. J. Filed Aug. 2, 1947. 2 claims. (Cl. 206-45.31.) The container has a sliding closure to cover and protect the merchandise when in the closed position.

2,593,400. Fireproofing compositions. Jules J. Rakos, Beyoglu-Istanbul, Turkey. Filed Oct. 5, 1948. 2 claims. (Cl. 106-15.) The composition, which is useful in protection against persistent types of flames, contains 48% sodium silicate, 20% trisodium phosphate, 20% lithopone, 10% quartz, 1% formaldehyde, and 1% sodium hydroxide.

2,593,430. Carton. William P. Frankenstein, Cincinnati, Ohio. Filed Jan. 27, 1947. 20 claims. (Cl. 206-45.19.) A container for glassware has cushioning or shock-insulating walls.

2,593,458. Method of purifying solid saturated fatty acids containing unsaturated free fatty acids and other soluble impurities. Leslie G. Jenness, assignor to The Trendex Co., Memphis, Tenn. Filed July 7, 1948. 22 claims. (Cl. 260-97.6.) Tall oil is hydrogenated, formed into discrete particles, and extracted with a mixture of benzene and heptane.

2,593,503. Method of recovering heat and chemicals from the residual liquor resulting from the digestion of cellulosic fibrous material. George H. Tomlinson and George H. Tomlinson II, assignors to Howard Smith Paper Mills, Ltd., Montreal, Canada. Filed Jan. 10, 1946. 11 claims. (Cl. 23-48.) A black liquor recovery furnace has a special nose baffle which is constructed below the vapor superheater to shield the superheater tubes from direct furnace radiation and to deflect the normal vertical flow of heating gases to a circuitous path upward and through an open fluid-cooled furnace pass.

2,593,608. Folded bag. Adolf G. F. Rambold, assignor to Teepack Specialmaschinen G.m.b.H., Viersen/Rhld. (Germany.)

Filed July 8, 1948. 3 claims. (Cl. 99-77.1.) An infusion bag for tea and the like is formed of water-permeable paper or perforated cellophane.

2,593,611. Plant for shaping asbestos cement. William H. Rooksby, assignor to Turners Asbestos Cement Co., Ltd., Spotland, Rochdale, England. Filed June 1, 1946. 17 claims. (Cl. 92-66.)

2,593,689. Lamp container. Don G. Mitchell, assignor to Sylvania Electric Products, Inc., Emporium, Pa. A container for electric light bulbs includes a provision for reading the wattage and testing the lamps without removing them from the package.

2,593,708. Method for producing paper-covered wood veneer. Richard N. Ware, Jr., and Reginald Cannon, assignors to Chicago Mill and Lumber Co., Chicago, Ill. Filed Nov. 13, 1948. 1 claim. (Cl. 154-124.) An apparatus for the formation of paper-covered wood veneer includes a device for heating and steam spraying the veneer while it is flat.

2,593,773. Folding box or carton. David Levkoff, Great Neck, N. Y. Filed Jan. 14, 1949. 8 claims. (Cl. 229-41.) A collapsible carton incorporates connector segments between the end walls and the section of the bottom which move with each of the other parts into the collapsed or erected position of the box.

2,593,778. Carton. Robert F. McGinnis, Cedar Rapids, Iowa. Filed Oct. 6, 1947. 9 claims. (Cl. 229-17.) A cereal package has an inner liner of waxed paper and a pouring spout.

2,593,834. Transparent traylike structure. Frank D. Bergstein, Cincinnati, Ohio. Filed Jan. 6, 1947. 1 claim. (Cl. 229-23.)

2,593,863. Method of producing sheets of indefinite length composed of slitted wood veneer and a flexible backing. Armin Elemendorf, Winnetka, Ill. Filed March 14, 1947. 4 claims. (Cl. 144-309.) A method for the high speed production of a continuous sheet of thick wood veneer which is backed with heavy paper.

2,593,895. Shipping container. William R. Kohl, Glenview, Ill. Filed Aug. 17, 1948. 2 claims. (Cl. 229-27.) A container for potted plants and the like has a flanged end structure.

2,593,965. Carton feeding apparatus. Preston J. Blackwell, assignor to Robert Gair Co., Inc., New York, N. Y. Filed Oct. 5, 1948. 10 claims. (Cl. 226-129.)

2,593,966. Container with individual inscription. Samuel H. Born, Bethlehem, Pa. Filed Feb. 23, 1949. 2 claims. (Cl. 229-8.) A gift carton has a sheet of metal foil suitable for a greeting.

2,594,050. Clasp type closure for envelopes. George H. Matthiesen, Chicago, Ill. Filed Nov. 12, 1947. 1 claim. (Cl. 229-78.)

2,594,095. Collapsible paper rewinding shaft. Robert E. Torregrossa and Roy D. Babington, Bogalusa, La. Filed April 9, 1951. 6 claims. (Cl. 242-72.) A rewinder shaft is composed of two elongated concave-convex shaft-forming sections and means for slidably securing the sections together and laterally moving the sections apart.

2,594,156. One-piece reinforced carton. Reynolds Guyer, assignor to Waldorf Paper Products Co., St. Paul, Minn. Filed July 12, 1946. 2 claims. (Cl. 229-37.) The side and end walls of a cheese carton are constructed of 3-ply laminated board to provide stacking strength.

2,594,241. Means for forming articles such as patty pans from paper or other thin materials. James T. Williamson, Dunedin, New Zealand. Filed July 15, 1947. 9 claims. (Cl. 93-60.) A fluted die- and punch mechanism.

2,594,252. Cell case machine. Daniel R. Vail and Robert A. De Luca, assignors to Henry C. Tuttle, Boston, Mass. Filed Feb. 15, 1946. 16 claims. (Cl. 93-37.) An apparatus for assembling slotted partition strips.

2,594,258. Detergent composition. Charles B. Durgin, assignor to Monsanto Chemical Co., St. Louis, Mo. Filed May 12, 1949. 3 claims. (Cl. 252-140.) The detergent contains the condensation product of tall oil and ethylene oxide, tetrasodium pyrophosphate, attapulgite, sodium bicarbonate, carboxymethylcellulose, and water.

2,594,267. Chemical furnace. Leslie S. Wilcoxson, assignor to The Babcock & Wilcox Co., New York, N. Y. Filed Feb. 19, 1947. 5 claims. (Cl. 23-277.)

April 29, 1952

R423,486. Method of and apparatus for producing valved or sleeved bags. Harry E. Lee, assignor to St. Regis Paper Co., New York, N. Y. Original No. 2,387,274, dated Oct. 23, 1945. Application for reissue Dec. 27, 1951. 31 claims. (Cl. 93-8).

2,594,287. Pallet container assembly for shipping articles. Larry J. Budd, assignor to Pallet Devices, Inc., Melrose Park, Ill. Filed Jan. 17, 1949. 7 claims. (Cl. 206-65.) The construction of a paperboard pallet is described.

2,594,303. Process for the recovery of valuable constituents from waste sulphite liquor. Hands Ehrensperger, assignor to St. Lawrence Paper Mills Co. Ltd., Montreal, Canada. Filed Aug. 22, 1949. 4 claims. (Cl. 260-124.) Products suitable as plastics are formed by treatment of spents sulphite liquor with quaternary ammonium bases and salts.

2,594,376. Bottle carrier. Edwin L. Arneson, assignor to Morris Paper Mills, Chicago, Ill. Filed Nov. 13, 1947. 2 claims. (Cl. 229-31.) The carrier is reinforced by a multi-ply construction in the side wall, end wall, and handle parts.

2,594,377. Bottle carrier. Edwin L. Arneson, assignor to Morris Paper Mills, Chicago, Ill. Filed Feb. 15, 1949. 1 claim. (Cl. 229-28.) The carrier has cross-partition members which are provided with locking elements to maintain the cross-partition structure and the carrier in the erected condition.

2,594,384. Fungi and bacteria resistant papermakers' felts and process for preparing same. Paul G. Benignus, assignor to Monsanto Chemical Co., St. Louis, Mo. Filed Nov. 12, 1946. 10 claims. (Cl. 117-76.) The felt is impregnated with copper 8-quinolinate, a *N,N'*-diacyldiaminomethane, and a resinous condensation product of the dibutyl ether of tetramethylolmelamine.

2,594,394. Carton. Robert C. Casselman and David R. Dominie, assignors to Polaroid Corp., Cambridge, Mass. Filed Oct. 9, 1948. 9 claims. (Cl. 229-39.) A wax-lined chipboard container for rolls of positive and negative photosensitive sheet material.

2,594,400. Flat screen for pulp screening. Ben Cowan and Elijah Cowan, Montreal, Canada. Filed Nov. 19, 1949. 2 claims. (Cl. 92-32.) A diaphragm-type flat screen embodies sealing means for preventing leakage between the walls of the diaphragm and the marginal portions of the diaphragm.

2,594,431. Detergent compositions. Jay C. Harris and Milton Kosmin, assignors to Monsanto Chemical Co., St. Louis, Mo. Filed April 1, 1950. 5 claims. (Cl. 252-135.) The detergent consists of 15 to 30 parts of the condensation product of tall oil and ethylene oxide, 20 to 50 parts of tetrasodium pyrophosphate, and carbohydrate material to make 100 parts (starch, carboxymethylcellulose, and their mixtures).

2,594,453. Detergent compositions. Milton Kosmin and Jay C. Harris, assignors to Monsanto Chemical Co., St. Louis, Mo. Filed April 1, 1950. 5 claims. (Cl. 252-135.) The detergent contains 15–30 parts of the condensation product of tall oil and ethylene oxide, 20–50 parts trisodium phosphate, 20–40 parts sodium sulphate, and 0.1–5 parts carboxymethylcellulose.

2,594,504. Carton for holding eggs. Leona W. Schmirler, Wausau, Wis. Filed July 22, 1949. 2 claims. (Cl. 229-28.)

2,594,628. Box construction. Wil Evans, assignor to California Container Corp., Emeryville, Calif. Filed Jan. 14, 1946. 4 claims. (Cl. 229-34.) Box trays have end walls so designed as to permit the trays to be assembled on locking strips as they are stacked.

2,594,804. Device for automatically stripping cutout box blanks from offal or waste. Harold A. Ringel, New Orleans, La. Filed Dec. 5, 1946. 11 claims. (Cl. 93-36.) A creased or scored sheet of cardboard is subjected to the action of selective suction rolls for separating the waste.

2,594,849. Apparatus for manufacturing valve bags. Daniel Belcher, Russell J. Williams, and James E. Voege, assignors to Bemis Bros. Bag Co., St. Louis, Mo. Filed April 15, 1949. 5 claims. (Cl. 93-8.) An apparatus is adapted for the continuous production of paper valve bags which incorporate a valve sleeve adhesively secured to a corner of the bag.

2,594,924. Partition assembling machine. Robert J. Hickin, Rittman, Ohio. Filed July 22, 1947. 15 claims. (Cl. 93-37.) A series of strips is fed in interleaved arrangement; the assemblies are adapted for insertion into 24-bottle cases.

2,594,937. Flame retarding composition. Edgar A. Lauring, assignor to Minnesota and Ontario Paper Co., Minneapolis, Minn. Filed Sept. 6, 1949. 7 claims. (Cl. 260-18.) A flame-retardant composition for board, paper, and the like contains a thermoplastic phenolic resin, bodied linseed oil, sodium tetraborate, boric acid, calcium carbonate, and lithopone.

2,595,046. Method of forming paper closure members for paper containers. Walter E. Amberg, assignor to Lily-Tulip Cup Corp, Chicago, Ill. Filed Oct. 12, 1949. 2 claims. (Cl. 93-1.3.) This is a continuation of U. S. patent 2,568,697 (Sept. 25, 1951); the closure member incorporates a compressed solid peripheral bead which is engaged by the internal groove in the container.

2,595,202. Container. Edward A. Pardee, assignor to Shelmar Products Corp., Chicago, Ill. Filed Oct. 23, 1946. 1 claim. (Cl. 229-17.) A shipping, display, and dispensing container with a hingeable easel panel.

May 6, 1952

2,595,257. Protein adhesive composition. Clark C. Heritage, assignor to Weyerhaeuser Timber Co., Longview, Wash. Filed July 13, 1948. 9 claims. (Cl. 106-154.) The viscosity of soy-

bean glue for plywood is stabilized by the addition of bark or selected components of bark.

2,595,325. Paper web guide mechanism. John R. Baumgartner, Milwaukee, Wis. Filed Dec. 18, 1950. 2 claims (Cl. 271-2.6.) An adjustable paper web guide mechanism is designed to accommodate webs of different width.

2,595,446. Valved bag and its manufacture. Charles V. Brady and August F. Ottinger, assignors to Bemis Bro. Bag Co., St. Louis, Mo. Filed Sept. 4, 1948. 17 claims. (Cl. 229-62.5.) A paper valved bag embodies a valve sleeve which can serve as a removable label for the display of advertising matter.

2,595,630. Side gauge for sheet feeders. Frank R. Belluche, assignor to The Christensen Machine Co., Racine, Wis. Filed Nov. 7, 1949. 5 claims. (Cl. 271-52.) A sheet feeder for handling cardboard incorporates a plush-covered roll which coacts with a smooth-surfaced metal roll to maintain a sufficient grip upon the sheet to preclude rebound and overtravel.

2,595,678. Carton. David Levkoff, Great Neck, N. Y. Filed Nov. 2, 1948. 3 claims. (Cl. 229-31.) A carton for fruits and the like has a cover which is provided with a display window covered with transparent sheeting.

2,595,733. Coated abrasive article and the method of making the same. Frank J. Tone and Harý C. Martin; assignor to The Carborundum Co., Niagara Falls, N. Y. Filed July 15, 1940. 9 claims. (Cl. 51-298.) A method of bonding grit in the manufacture of sandpaper.

2,595,916. Light sensitive positive printing diazotype paper having a calendered surface. Wilhelmus H. G. Bartels, assignor to Chemische Fabriek L. Van Der Grinten, Venlo, Netherlands. Filed April 20, 1948. 9 claims. (Cl. 95-7.)

2,595,935. Wet strength paper and process for the production thereof. John H. Daniel, Jr., and Chester G. Landes, assignors to American Cyanamid Co., New York, N. Y. Filed Aug. 3, 1946. 15 claims. (Cl. 92-3.) Paper is impregnated with a resin (e.g., a polyethylenepolyamine—α-dichlorohydrin condensation product) and cured with heat.

2,596,014. Preparing wet-strength paper using polyarylbiguanide-urea resin. James R. Dudley and John A. Anthes, assignors to American Cyanamid Co., New York, N. Y. Filed March 5, 1947. 12 claims. (Cl. 92-21.) A wet-strength paper includes the product of reaction between a urea-formaldehyde resin and the water-soluble product of reaction between dicyanodiamide, formaldehyde, and an alkylaniline.

2,596,015. Wood-chip preparation for digesters from unbarked logs. Archibald B. Dunwody, Evanston, Ill. Filed Nov. 2, 1948. 1 claim. (Cl. 241-23.) Chips from unbarked logs are classified on a riffler into a fraction suitable for the manufacture of high quality paper, a second fraction suitable for lower grades, and fractions containing knots, dirt, bark, and other foreign material.

2,596,050. Capmaking machine. Rudolph Sonnenberg, assignor to Mid-West Bottle Cap Co., Belvidere, Ill. Filed Oct. 31, 1945. 15 claims. (Cl. 93-1.3.) Method of forming milk bottle caps.

2,596,087. Edible material container. Paul A. Shoudy, assignor to California Container Corp., Oakland, Calif. Filed Oct. 12, 1949. 2 claims. (Cl. 229-39.) An ice cream container is constructed from corrugated board and a liner of sulphite or parchment paper.

May 13, 1952

2,596,187. Bark-removing machine having horizontally and vertically guided cutter. William J. Watts, Philipsburg, and Frank B. Cadman, Osceola Mills, Pa. (Cadman assignor to Watts). Filed May 10, 1950. 5 claims. (Cl. 144-208.) A mechanical barker includes means for feeding a log under the cutters at variable speeds and for rapidly reciprocating the cutter on the log.

2,596,205. Partitioned tray or holder. Kenneth T. Buttery, assignor to Sutherland Paper Co., Kalamazoo, Mich. Filed Feb. 12, 1951. 5 claims. (Cl. 229-28.) A tray for packaging bakery products is formed from an integral blank and enclosed in a transparent heat-sealable wrapper.

2,596,208. Winding machine. Thomas N. Carter, assignor to Cameron Machine Co., Brooklyn, N. Y. Filed Jan. 6, 1950. 5 claims. (Cl. 242-66.) The winder roll is driven by a surface winding drum and a top pressure or riding roll.

2,596,218. Telescoping box. Charles W. Dennis, Brooklyn, N. Y. Filed March 7, 1946. 1 claim. (Cl. 229-43.) The top of a two-piece, telescoping cylindrical powder box is constructed from two pieces of paper or board and the bottom of three pieces.

2,596,224. Paper container. Wilfred A. Eaton and Roy S. Sanford, assignors of one half to Ex-Cell-O Corp., Detroit, Mich., and one half to Ace Carton Corp., Chicago, Ill. Filed Jan. 31, 1946. 19 claims. (Cl. 229-37.) A liquidproof, siftproof container for liquids or fine powders.

2,596,225. Container. Wilfred A. Eaton, assignor of one half to Ex-Cell-O Corp., Detroit, Mich, and one half to Ace Carton Corp., Chicago, Ill. Filed May 23, 1946. 29 claims. (Cl. 229-37.) A leak- and siftproof paperboard container (e.g., for milk) has a triangular cross section and a flat top.

2,596,241. Treatment of the spent cooking liquor of an ammonia base sulphite pulping process. Donald Helleur, Assignor to Price Brothers & Co., Ltd., Quebec, Canada. Filed Dec. 20, 1948. 4 claims. (Cl. 23-129.) The spent liquor is treated with magnesium oxide to liberate ammonia and the magnesia-treated liquor is evaporated and burned.

2,596,261. Carton. Louis D. Liskin, Ridgefield, N. J., assignor to Standard Corrugated Case Corp. Filed April 4, 1950. 1 claim. (Cl. 229-16.) A carton for bottled beer has double-layer bottom and end wall structures.

2,596,292. Pad for upholstery and the like. Wade E. Sackner, assignor to Sackner Products, Inc., Grand Rapids, Mich. Filed Aug. 30, 1948. 7 claims. (Cl. 255-184.) The pad is composed of kraft paper on both sides of which are layers of cellulose wadding.

2,596,331. Severable multiple unit case. Kenneth C. Ferguson, assignor to Inland Container Corp., Indianapolis, Ind. Filed March 9, 1950. 4 claims. (Cl. 229-27.) The carton is adapted for retail packaging of bottled goods.

2,596,448. Apparatus for stacking sheet material. Thomas Toronto, assignor to Robert Gair Co., Inc., New York, N. Y. Filed March 5, 1946. 2 claims. (Cl. 271-89.) An automatic jogging mechanism is adapted to jog sheets of boards.

2,596,496. Noncombustible coating composition and method of applying. Paul E. Marling and Morris L. Nielsen, assignors to Monsanto Chemical Co., St. Louis, Mo. Filed Dec. 20, 1948. 6 claims. (Cl. 260-735.) The water-insoluble reaction product of five moles of phosphorus oxychloride and one mole of ammonia, in combination with chlorinated rubber, is used as a flameproofing composition.

2,596,586. Machine for treating fibrous material. Charles W. Morden, assignor to Morden Machines Co., Portland, Ore. Filed June 19, 1947. 10 claims. (Cl. 92-26.) A refiner consists essentially of a vertical cylindrical tank with a pair of concentric attritioning rings mounted in the wall of the vessel.

2,596,625. Web feeding mechanism for package forming machines. John G. Vergobbi, assignor to Pneumatic Scale Corp., Ltd., Quincy, Mass. Filed Oct. 1, 1948. 5 claims. (Cl. 93-12.) Means for feeding a web of thin paper lining material into operative position to be wrapped about a forming block to form a bag or inner liner for a package.

2,596,645. Method of making acoustic diaphragms. Joseph B. Brennan, Cleveland, Ohio. Filed Jan. 10, 1947. 6 claims. (Cl. 92-54.) Fibrous material is deposited from water or air suspension upon a concave form.

2,596,707. Box. Henry L. Metzger, Castleton-on-Hudson, N. Y. Filed April 23, 1948. 6 claims. (Cl. 229-45.) A container for cheese.

2,596,724. Method and apparatus for determining the freeness of wood pulp. William G. Reynolds, Cottondale, Ala. Filed Dec. 8, 1949. 7 claims. (Cl. 73-63.) An apparatus for the determination of the freeness of pulp suspensions while on a moving fourdrinier wire.

2,596,875. Method of handling waste suphite liquor. Thomas W. Stewart, assignor to Weyerhaeuser Timber Co., Longview, Wash. Filed May 26, 1950. 4 claims. (Cl. 159-47.) Spent magnesium-base suphite liquor is concentrated in multiple-effect evaporators at successively increasing pressures. The concentrated liquor is delivered from the last effect at a pressure of 15 p.s.i. to a storage tank, from which it is fired without further heating.

2,596,923. Closing device for paper bags. Adolf Bossart, assignor to Otto Frischknecht, St. Gallen, Switzerland. Filed Jan. 30, 1947. 2 claims. (Cl. 229-65.) The arms of a flat two-armed bendable closing member are threaded through holes in the wall and the flap of the bag.

2,596,935. Nitrogen-phosphorus composition and process for same. John E. Malowan and Forrest R. Hurley, assignor to Monsanto Chemical Co., St. Louis, Mo. Filed Dec. 30, 1948. 5 claims. (Cl. 23-14.) A flame- and glowproofing composition is prepared by reaction of ammonia with phosphorous oxychloride in a hydrocarbon solvent boiling above 200°C.

2,596,936. Glowproofing composition comprising phenol-aldehyde resin and water-insoluble reaction product of phosphoryl chloride and anhydrous ammonia. Morris L. Nielsen and Howard K. Nason, assignors to Monsanto Chemical Co., St. Louis, Mo. Filed Dec. 30, 1948. 8 claims. (Cl. 260-38.) The product is a combination of a resorcinol- or phenol-formaldehyde resin and the product of the reaction of ammonia and phosphorus oxychloride.

2,596,937. Intumescing composition composed of a nitrogen phosphorus compound with an aldehyde resin. Morris L. Nielsen, assignor to Monsanto Chemical Co., St. Louis, Mo. Filed Dec. 30, 1948. 7 claims. (Cl. 260-39.) A flameproofing agent consists of a combination of a melamine- or urea-formaldehyde

resin and the product of the reaction of nitrogen with phosphorus oxychloride.

2,596,938. Coating composition composed of nitrogen-phosphorus compound with an aldehyde resin together with a water-soluble alkyd resin. Morris L. Nielsen, Russell W. Arnold, and Earl C. Chapin, assignors to Monsanto Chemical Co., St. Louis, Mo. Filed Dec. 30, 1948. 6 claims. (Cl. 260-29.4.) A flame-retardant composition consists of a water dispersion of a water-soluble urea-formaldehyde resin, the product of the reaction of ammonia and phosphorus oxychloride, and a citric acid-glycerol condensation product.

2,596,939. Fire retarding coating composition composed of a nitrogen-phosphorus compound with an aldehyde resin and polyhydroxy alcohol. Morris L. Nielsen and Paul E. Marling, assignors to Monsanto Chemical Co., St. Louis, Mo. Filed Dec. 30, 1948. 4 claims. (Cl. 260-29.4.) A fire-retarding composition contains the reaction product of ammonia and phosphorus oxychloride, an amine- or amide-aldehyde resin (e.g., urea-formaldehyde resin), and pentaerythritol as a plasticizer.

May 20, 1952

R23,501. Bottle carrier. Stephen Lighter, assignor to Gaylord Container Corp., St. Louis, Mo. Original No. 2,535,741, dated Dec. 26, 1950. Application for reissue Dec. 14, 1951. 8 claims. (Cl. 229-28.) A multicompartment cardboard bottle carrier with a special carrying handle.

2,597,006. Water-insoluble adhesive composition. Joseph J. Koenig, Frank G. Erskine, and Albert R. McManus, assignors to Gaylord Container Corp., St. Louis, Mo. Filed Aug. 13, 1948. 6 claims. (Cl. 106-154.) The adhesive contains 1800 lb. of clay, 1600 lb. of isolated protein, and 128 lb. of potassium hydroxide in 715 gal. of water and is used for laminating board for V boxes.

2,597,087. Synthetic resin coated paper. William W. Cowgill, assignor to United States Rubber Co., New York, N. Y. Filed April 9, 1951. 4 claims. (Cl. 117-155.) The coating agent is a mixture of a copolymer of styrene and acrylonitrile and one of 1,3-butadiene and acrylonitrile; 0.1 to 3 lb. are used per 1000 sq. ft. The highly glossy film is tenaciously adhered to the paper surface.

2,597,171. Chlorine containing condensation products of phenols and sulphonated acetaldehydes. Julian A. Otto and Everett E. Gilbert, assignors to Allied Chemical & Dye Corp., New York, N. Y. Filed June 8, 1949. 17 claims. (Cl. 92-21.) A slime-control agent is formed by heating phenol with acetaldehydedisulphonic acid and an acid condensing agent and chlorinating the resulting mixture.

2,597,289. Paper box. Cecil Caskey, Mingo Junction, Ohio. Filed July 26, 1948. 4 claims. (Cl. 229-32.) A folding box for candy and the like.

2,597,305. Bag. James F. Doyle, assignor to Arkell Safety Bag Co., New York, N. Y. Filed Nov. 20, 1946. 4 claims. (Cl. 229-53.) The bag is formed of two plies of crinkled paper laminated with an asphaltic adhesive.

2,597,377. Prepackaging unit for rayon yarn and the like. Kenneth V. Robinson, assignor to Atlanta Paper Co., Atlanta, Ga. Filed March 20, 1948. 2 claims. (Cl. 229-87.) A shipping container for packages of wound rayon yarn.

2,597,430. Nitric acid and bisulfite digestion of fibrous vegetable material. Gilbert Baudiniere, Paris, France. Filed July 30, 1947. 3 claims. (Cl. 92-9.) Straw is digested with nitric acid (12° Bé.), the acid is neutralized with lime, and the product is then digested with 2.5% sodium bisulphite.

2,597,511. Selectively demetalizing condenser paper. Glenn L. Mellen and Vincent C. Hall, Jr., assignors to National Research Corp., Cambridge, Mass. Filed Oct. 1, 1949. 7 claims. (Cl. 219-19.) A method for vaporizing the metallic coating from certain areas of a zinc-coated paper.

2,597,809. Manufacture of syntans. John Miglarese, assignor to The United States Leather Co., New York, N. Y. Filed Sept. 8, 1948. 4 claims. (Cl. 260-124.) A mixture of water-soluble soda lignin (Meadol or Indulin) and phenol is treated with concentrated sulphuric acid to give a water-soluble compound suitable for tanning.

2,597,810. Container having slide-operated fold-back cover. Harold L. Myers, Morristown, N. J. Filed Nov. 8, 1947. 4 claims. (Cl. 229-19.) The upper portion of a slide-type box can be automatically adjusted to a display position.

2,597,812. Tensile testing device. Jules J. Perot, Jr., and George Cawley, assignors to The Patent and Licensing Corp., New York, N. Y. Filed Dec. 12, 1947. 1 claim. (Cl. 73-15.6.) A device for measuring the tensile strength of roofing felt while immersed in molten asphalt.

May 27, 1952

2,597,845. Egg shipping container. Harry C. Reeser, assignor to The Patent and Licensing Corp., New York, N. Y. Filed March 1, 1949. 6 claims. (Cl. 229-15.) The case is formed of two identical flat blanks with a centrally located transverse partition member which divides the case into two compartments.

2,597,846. Container for shipment of eggs. Harry C. Reeser, assignor to The Patent and Licensing Corp., New York, N. Y. Filed March 1, 1949. 3 claims. (Cl. 229-15.) The container is designed to provide double thickness of material for the bottom and end walls and a load-sustaining transverse partition.

2,597,847, Shipping container for eggs. Harry C. Reeser, assignor to The Patent and Licensing Corp., New York, N. Y. Filed March 1, 1949. 2 claims. (Cl. 229-15.) The case is formed from three flat blanks and has a two-ply shock-absorbing cushion on the bottom and side and end walls.

2,597,848. Egg container. Harry C. Reeser, assignor to The Patent and Licensing Corp., New York, N. Y. Filed July 19, 1949. 3 claims. (Cl. 229-15.) The container is formed with two-ply side and end walls and bottom and with a detachable cover.

2,597,901. Water repellent gypsum product and process of making same. Wallace C. Riddell and George B. Kirk, assignors to Henry J. Kaiser Co., Richmond, Calif. Filed Aug. 31, 1950. 20 claims. (Cl. 154-45.9.) The gypsum is coated with a mixture of calcium rosin soap and residual fuel oil; spent sulphite liquor or lignosulphonic acid is used as a dispersing agent.

2,597,918. Method of making tacking strip. Barney Boersma and A. Arnold Parcels, assignors to Sackner Products, Inc., Grand Rapids, Mich. Filed March 6, 1947. 4 claims. (Cl. 57-165.) Twisted strips of moistened kraft paper are compressed and immersed in microcrystalline wax at 250°F.

2,597,922. Carton-sealing and handling machine. John D. Conti, assignor to American Viscose Corp., Wilmington, Del. Filed Feb. 18, 1949. 8 claims. (Cl. 216-20.)

2,597,960. Yarn package support. William T. Stearn, assignor to Celanese Corp. of America, New York, N. Y. Filed Oct. 18, 1950. 8 claims. (Cl. 242-122.) A cone tube for a yarn package has a rigid end which is highly resistant to crushing.

2,597,994. Machine for making fluted containers. Roderick W. Hoag, Melrose, Mass. Filed June 24, 1948. 2 claims (Cl. 53-61.) A machine for converting a corrugated paper web into a succession of pockets made from the flutes of the corrugations.

2,598,050. Tissue dispension carton. Reynolds Guyer, assignor to Waldorf Paper Products Co., St. Paul, Minn. Filed June 10, 1948. 2 claims. (Cl. 229-17.) A pair of overlapping tongues are designed to interlock when pressed inwardly.

2,598,051. Carrier package. Reynolds Guyer and Russell J. Hennessey, assignors to Waldorf Paper Products Co., St. Paul, Minn. Filed Feb. 2, 1951. 8 claims. (Cl. 229-52.) A carrier for bottles or cans has a hole in the upper handle for carrying it.

2,598,071. Carton opening machine. Alfred G. Rose and James Page, assignors to Rose Brothers [Gainsborough] Ltd., Gainsborough, England. Filed Feb. 25, 1947. 5 claims. (Cl. 93-53.)

2,598,087. Method for producing chlorine dioxide. Morris Wayman and William H. Rapson, assignors to Canadian International Paper Co., Montreal, Canada. Filed June 2, 1949. 5 claims. (Cl. 23-152.) Chlorine dioxide is produced from sulphur dioxide and an aqueous solution of sodium chlorate.

2,598,116. Process for cooling sulfur burner gas. Horace A. Du Bois, assignor to Paper Patents Co., Neenah, Wis. Filed May 7, 1948. 5 claims. (Cl. 183-120.)

2,598,123. Container. James A. Hollinshead, assignor to Consolidated Paper Co., Monroe, Mich. Filed Oct. 11, 1949. 2 claims. (Cl. 229-16.) A reusable beer case.

2,598,135. Carton closing and flap tucking machine. Joseph M. Schmied, assignor to Package Machinery Co., East Longmeadow, Mass. Filed Nov. 26, 1949. 6 claims. (Cl. 53-147.)

2,598,149. Carton with easel-forming closure member. William E. Turner, assignor to O. B. Andrews Co., Chattanooga, Tenn. Filed Dec. 19, 1949. 6 claims. (Cl. 206-45.22.) A carton for the display of pencils and the like.

2,598,150. Container blank delivery mechanism. Harry K. Wethe and Robert H. Duncanson, assignors to Package Machinery Co., East Longmeadow, Mass. Filed Aug. 17, 1949. 5 claims. (Cl. 271-14.) A device to remove warped or bent sheets from a stack of blanks, flatten them, and return them to a delivery table of a box-forming machine.

2,598,173. Calendered crinkled paper and process of manufacture. Ferdinand W. Humphner, River Forest, Ill. Filed June 28, 1947. 10 claims. (Cl. 154-33.05.) Paper is creped to form interrupted folds and the resulting sheet is passed through a calender at an angle while applying a bonding material to unite the folds to the body of the sheet.

2,598,257. Wax product and process of preparing the same. Joseph B. Hill and Seymour W. Ferris, assignors to Sun Oil Co., Philadelphia, Pa. Filed May 29, 1948. 4 claims. (Cl. 196-149.) A method is outlined for the isolation of a wax fraction (melting about 190°F.) which is suitable for laminating papers and which does not increase the translucency to visible light of uncoated sulphite paper.

2,598,311. Manufacture of vanillin. Eugene W. Schoeffel, assignor to Salvo Chemical Corp., Rothschild, Wis. Filed May 4, 1950. 12 claims. (Cl. 260-600.) Alkaline spent sulphite liquor is treated with oxygen at about 200°C. and 1000 p.s.i. for about 10 minutes.

2,598,332. Cold process transfer coating composition. George Walton, Cincinnati, Ohio. Filed Nov. 29, 1948. 4 claims. (Cl. 106-8.) A coating for paper and the like contains 7 to 25% of a solid wax, 50 to 70% of a nondrying oil (S.A.E. viscosity not over 250), and a coloring agent.

2,598,373. Commodity package. George H. Harry, Buffalo, N. Y. Filed Feb. 9, 1950. 1 claim. (Cl. 99-174.) A meat package consists of a waxed paper inner liner, a stiffening member, and a transparent outer wrapper.

2,598,388. Storage bin with pressure-relieving baffles. Alfred T. Hurter, assignor to Stadler, Hurter & Co., Montreal, Canada. Filed April 16, 1948. 2 claims. (Cl. 222-459.) A chip bin is so designed as to prevent bridging or arching of the chips across the opening.

2,598,424. Production of cyclopentadiene-tall oil compositions. Carl F. Peters, assignor to Velsicol Corp., Chicago, Ill. Filed Oct. 9, 1946. 11 claims. (Cl. 260-97.5.) Cyclopentadiene is polymerized at 400 to 550°F. and the polymer is reacted with tall oil at 400 to 650°F.; the product is a varnish or lacquer coating composition.

2,598,535. Sampling device. Charles M. Green, assignor to Mosinee Paper Mills Co., Mosinee, Wis. Filed June 30, 1948. 4 claims. (Cl. 73-422.) A device for the removal of pulp samples from a digester during a cook.

2,598,558. Locking device for box covers. Charles L. Kanty, Rochester, N. Y. Filed Feb. 10, 1950. 1 claim. (Cl. 229-33.)

2,598,569. Machine for setting-up box blanks. David Levkoff, Great Neck, N. Y. Filed Feb. 7, 1948. 5 claims. (Cl. 93-53.)

2,598,580. Bleaching or brightening a web of mixed fibers. Robert L. McEwen and Fred R. Sheldon, assignors to Buffalo Electro-Chemical Co., Inc., Buffalo, N. Y. Filed Oct. 8, 1947. 2 claims. (Cl. 92-1.) Mechanical pulp is bleached with peroxide, blended with sulphite pulp, formed into a sheet, and further bleached with hydrogen peroxide and a phosphate.

2,598,627. Folding carton. Arthur J. Weiss, assignor to Robert Gair Co., Inc., New York, N. Y. Filed Oct. 11, 1949. 2 claims. (Cl. 229-62.) A preglued folding carton has a cellophane-covered display opening.

June 3, 1952

2,598,733. Wiping blade for coating devices. Edgar Warner, assignor to Champion Paper and Fibre Co., Hamilton, Ohio. Filed March 16, 1949. 6 claims. (Cl. 118-113.) The wiping blade consists of a rotating rod and a bearing which is continuous throughout the length of the rod.

2,598,809. Conveyor mechanism for folding carton blanks. Albert W. Liebl, assignor to Container Corp., of America, Chicago, Ill. Filed Sept. 4, 1948. 15 claims. (Cl. 93-49.)

2,598,820. Synchronous drive. Alonzo A. Neese, assignor to Beloit Iron Works, Beloit, Wis. Filed Nov. 29, 1949. 1 claim. (Cl. 164-61.) A drive for a sheet cutter.

2,598,852. Feed regulator for paper machinery. Stephen A. Staege, assignor to The Black-Clawson Co., Hamilton, Ohio. Filed July 24, 1946. 3 claims. (Cl. 92-46.) A pump is positioned to supply stock from the screen to the wire.

2,598,908. Coating head. Samuel B. Grimson, assignor to Color Research Corp., Dover, Del. Filed Feb. 24, 1950. 5 claims. (Cl. 118-401.) A narrow slotlike orifice is located in the wall of the coating-supply reservoir; the orifice is fed uniformly throughout its length.

2,598,945. Box with locking handle. Gerald A. Taylor, assignor to Cohoes Envelope Co., Inc., Cohoes, N. Y. Filed July 27, 1949. 3 claims. (Cl. 229-45.) A suit box has a board, twisted paper, or rope handle.

2,598,987. Spoon cover. Gilbert E. Franzen, Garden Grove, Calif. Filed March 15, 1949. 3 claims. (Cl. 229-43.) An ice cream container has a cover with a scoop-shaped spoon.

2,599,008. Box forming machine. Charles E. Palmer, assignor to Package Machinery Co., East Longmeadow, Mass. Filed Nov. 8, 1949. 22 claims. (Cl. 93-51.1.) The machine folds prescored or creased blanks into box form and adhesively secures the box in its setup condition.

2,599,090. Bark-removing apparatus comprising rotor and stationary cage. James R. Clark, Mobile, and Spencer M. Adams, Coden, Ala. Filed May 4, 1950. 7 claims. (Cl. 144-208.) A barker consists of a stationary cylindrical cage structure and a rotor mounted within the cage.

2,599,091. Forming pigment in cellulose fiber and paper containing the pigmented fiber. William L. Craig, assignor to R. T. Vanderbilt Co., Inc., New York, N. Y. Filed April 23, 1946. 15 claims. (Cl. 92-3.) Pulp is gelatinized by a strong solution of calcium chloride and the calcium is precipitated as the carbonate; a sheet of paper may be made with 5 to 25% of this product.

2,599,092. Multiple layer paper containing pigmented pulp and method of making. William L. Craig, assignor to R. T. Vanderbilt Co., Inc., New York, N. Y. Filed April 30, 1946. 10 claims. (Cl. 92-3.) The product of U. S. patent 2,599,091 is used to form an outer liner for a multilayer sheet.

2,599,093. Pigmented cellulosic fiber. William L. Craig, assignor to R. T. Vanderbilt Co., Inc., New York, N. Y. Filed March 17, 1948. 12 claims. (Cl. 106-204.) Highly pigmented pulp consists of the dried residue of swollen, hydrated, and gelatinized cellulosic fibers and a pigment (inorganic salts of barium, calcium, or zinc) which is precipitated *in situ* by the action of one soluble salt upon a second in the presence of the gelatinized fiber.

2,599,094. Cellulosic fibrous calcium silicate pigment, a method of making it, and a sheet of paper containing it. William L. Craig, assignor to R. T. Vanderbilt Co., Inc., New York, N. Y. Filed Dec. 10, 1949. 15 claims. (Cl. 92-3.) The gelatinized fibers containing calcium chloride are treated with sodium silicate to precipitate therein calcium silicate; a sheet of paper may contain from 5 to 25% of this product.

2,599,130. Laminated sheet material. George G. Rumberger and Alfred M. Heald, assignors to Marathon Corp., Rothschild, Wis. Filed Sept. 19, 1949. 13 claims. (Cl. 154-50.) A laminate consists of at least two base sheets and a film of wax which is substantially nonreactive with urea.

2,599,374. Liquid adhesive applicator and control apparatus therefor. William L. Davis, assignor to Union Bag & Paper Corp., New York, N. Y. Filed July 10, 1948. 3 claims. (Cl. 118-7.) The apparatus is designed to control the level in paste pots on bag-making machines.

2,599,393. Bag supporting means for bag closing and sealing machines. Harold V. Kindseth, assignor to Bemis Bro. Bag Co., Minneapolis, Minn. Filed Dec. 1, 1950. 11 claims. (Cl. 53-57.)

2,599,430. Register control system for web cutting mechanisms. Ralph A. Beuerman, assignor to E. I. du Pont de Nemours & Co., Wilmington, Del. Filed March 29, 1950. 1 claim. (Col. 164-68.) Device for continuously cutting printed bands from a paper web.

2,599,442. Apparatus for stacking carton blanks. Alois Essex, Elmer E. Garrett, and John Kallenberg, assignors to The Sperry Corp., New York, N. Y. Filed March 4, 1950. 6 claims. (Cl. 271-71.)

June 10, 1952

R23,510. Method of making photographic paper. Edward Jahoda, assignor to H. P. Andrews Paper Co., New York, N. Y. Original No. 2,433,515, dated Dec. 30, 1947. Application for reissue Aug. 10, 1950. 3 claims. (Cl. 117-34.) A precoating of silica sol is applied to photosensitive papers.

2,599,543. Gyratory processing apparatus. James T. Coghill and Harold S. Hill, assignors to Curlator Corp., Rochester, N. Y. Filed June 6, 1946. 6 claims. (Cl. 92-26.) A gyratory refiner for pulp comprises two opposed coacting elements with tractive working surfaces.

2,599,567. Bag bottom structure. Harold E. McCrery and Albert E. Jesser, assignors to Plyfiber Container Co., Garwood, N. J. Filed Dec. 28, 1944. 10 claims. (Cl. 229-57.) A paper bag for fluid or plastic materials has a reinforced folded bottom structure in which the joints of superimposed folds are relatively offset and sealed.

2,599,571. Pulping wood with sodium carbonate-lime solution. Huguenin Miller, assignor to Watervliet Paper Co., Watervliet, Mich. Filed Jan. 16, 1946. 2 claims. (Cl. 92-13.) Chips are impregnated with a 3 to 8% sodium carbonate solution by heating in a closed vessel and the impregnated chips are pulped with an aqeous suspension of lime at 212 to 450°F.

2,599,572. Alkaline pulping of preimpregnated deciduous wood. Huguenin Miller, assignor to Watervliet Paper Co., Watervliet, Mich. Filed Feb. 1, 1946. 3 claims. (Cl. 92-13.) Chips are impregnated with a 2 to 6% sodium hydroxide solution and then pulped with lime.

2,599,625. Apparatus for forming enclosed blanket insulating strips. Lawrence M. Gilman, Gilman, Conn. Filed April 1, 1948. 1 claim. (Cl. 154-27.) An apparatus for continuously wrapping elongated strips of fibrous insulating material.

2,599,708. Inner lined folding carton. Herman Gottesman, assignor to The Permaline Co., Clifton, N. J. Filed Nov. 14, 1949. 2 claims. (Cl. 229-14.) A container for candy, cough lozenges, and the like, the liner of which is bonded to the inside of the box by pin-point lamination.

2,599,720. Back stand for rolls of paper. Bruno E. Prevost, assignor to John W. Bolton & Sons, Inc., Lawrence, Mass. Filed April 5, 1948. 11 claims. (Cl. 242-58.) A backstand incorporates several pairs of short core shafts, each with a journal or pivot member and all of the same diameter.

2,599,719. Grinding mills. Charles E. Pegg, assignor to E. S. and A. Robinson, Ltd., Bristol, England. Filed March 15, 1949. 3 claims. (Cl. 241-245.) A rotating stone is located eccentrically within a rotary drum so that it forms a wedge-shaped chamber into which the wood is fed to be ground between the cooperating surfaces of the stone and drum.

2,599,800. Shipping and carry-out carton. Raymond E. Wolfe, assignor to The Fairfield Paper and Container Co., Baltimore, Ohio. Filed March 4, 1949. 2 claims. (Cl. 229-39.) A container for bottled goods has interlocking vertical partitions.

2,599,878. Tube and method of making the same. Rudolph H. von Liedtke, assignor to McGraw Electric Co., Chicago, Ill. Filed Sept. 4, 1945. 1 claim. (Cl. 92-66.) Manufacture of wound paper tubes from pulp.

2,599,942. Paper winding machine. Gunnar Roen, Vikeland, Norway. Filed March 17, 1947. 12 claims. (Cl. 242-56.) A rewinder.

2,599,943. Process of making disintegrable top shot wads. Harold C. Russell and William N. King, assignors to Federal Cartridge Corp., Minneapolis, Minn. Filed Dec. 6, 1948. 2 claims. (Cl. 117-155.) Board is impregnated with a urea-formaldehyde resin and heated at 400 to 500°F. to render it brittle and disintegrable.

2,599,947. Paper coating apparatus. Robert A. Sherman and Luther O. Carlisle, assignors to A. E. Staley Manufacturing Co., Decatur, Ill. Filed Jan. 21. 1950. 2 claims. (Cl. 118-118.) A machine for applying colored starch-clay coating to board has a wire-wrapped smoothing roll.

2,599,962. Debarking machine having staggered flail-carrying drums for broadside attack on rotating logs. James K. Williford, Hickory, Miss. Filed Sept. 22, 1950. 9 claims. (Cl. 144-208.) Means for rotating the log within the barker.

2,600,004. Fluorescent optical bleaching agent. Stanley E. Krahler, assignor to E. I. du Pont de Nemours and Co., Wilmington, Del. Filed June 18, 1951. 3 claims. (Cl. 252-301.2.) The compound is selected from the group consisting of 4,4′-bis-(3-methoxy-2-naphthoylamino)stilbene-2,2′-disulphonic acid and its water-soluble salts.

2,600,105. Method of applying lace and like ornamental edging to boxes. Milford E. Fuller, assignor to Vickers-Armstrong Ltd., London, England. Filed May 12, 1948. 1 claim. (Cl. 93-57.)

2,600,114. Dual-purpose envelope. James G. Kerr, Washington, D. C. Filed June 5, 1945. 12 claims. (Cl. 229-73.) A dual-purpose mailing and return envelope.

2,600,130. Egg carton. Ruth M. Schilling, assignor to Shellmar Products Corp., Chicago, Ill. Filed Dec. 4, 1945. 8 claims. (Cl. 229-2.5.) A molded pulp egg carton consisting of three elements.

2,600,146. Envelope. Harlan M. Whitman, assignor to Curtis 1000, Inc., Hartford, Conn. Filed Oct. 2, 1947. 2 claims. (Cl. 229-92.1.)

2,600,265. Pulp molding die. Walter H. Randall, assignor to The Canal National Bank of Portland and William B. Nulty, Portland, Me., as trustees. Filed March 27, 1947. 1 claim. (Cl. 92-54.) An open-faced, sectional, wire-covered pulp-molding die.

2,600,322. Apparatus for affixing conducting tap straps to paper mounting strips. Edwin A. Raney, assignor to General Electric Co., Schenectady, N. Y. Filed July 31, 1948. 1 claim. (Cl. 154-1.6.) See also 2,601,005.

2,600,355. Bottom expander. Paul E. Wixon and Clarence E. Chapman, assignor to Joseph Shapiro, Baltimore, Md. Filed May 23, 1949. 3 claims. (Cl. 93-36.5.) Means for expanding the flange of a cup-shaped end-closure member against the side wall of the cup body.

June 17, 1952

2,600,487. Siftproof bag bottom. Merle E. Craig, assignor to Crown Zellerbach Corp., San Francisco, Calif. Filed July 6, 1948. 1 claim. (Cl. 229-59.) A siftproof, multi-ply bag for carbon black or the like has a pasted bottom structure.

2,600,504. Forming paper from modified calcium alginate fibers. Arthur Johnson and Edwin G. Millatt, assignors to Alginate Industries Ltd., London, England. Filed June 4, 1948. 6 claims. (Cl. 92-21.) Calcium alginate is reduced to short fibers, treated with sufficient sodium carbonate to combine with 15 to 55% of the calcium, and the swollen fibers are felted into a paper sheet.

2,600,593. Coating compositions. Ira Weber, assignor to Interchemical Corp., New York, N. Y. Filed July 28, 1950. 9 claims. (Cl. 260-21.) A dye is dissolved in a soybean oil-modified alkyd resin in a petroleum hydrocarbon and a urea-formaldehyde or other resin is dispersed in the solution.

2,600,606. Water-soluble derivatives of unsulfonated lignin. Walter J. Balon, assignor to E. I. du Pont de Nemours & Co., Wilmington, Del. Filed May 25, 1950. 8 claims. (Cl. 260-124.) One mole of lignin is treated with one mole each of boric acid and a phenol and the reaction product is made alkaline.

2,600,625. Log supporting and log manipulating device for wood debarking devices. Erik Ekholm and Victor C. Haner, assignors to Puget Sound Pulp and Timber Co., Bellingham, Wash. Filed May 26, 1947. 3 claims. (Cl. 144-208.) Means are provided for handling logs to which the limbs are still attached and for barking the limbs as well as the logs.

2,600,818. Air-drying wrinkle finish and method of making. William A. Waldie, assignor to New Wrinkle, Inc., Wilmington, Del. Filed Sept. 18, 1947. 11 claims. (Cl. 260-19.) The base of the varnish is phenylphenol-formaldehyde resin and oiticica oil; this is used with raw tung oil.

2,600,907. Single-facer drive. Elmer L. Mumma, assignor to F. X. Hooper Co., Inc., Glen Arm, Md. Filed Oct. 4, 1947. 8 claims. (Cl. 154-31.) A drive for a single-facer corrugating machine.

2,600,923. Test clamp for test specimen. Robert W. Rogers and Samuel Reback, assignors to Scott Testers, Inc., Providence, R. I. Filed June 18, 1947. 3 claims. (Cl. 24-248.) A toggle clamp for gripping test specimens which can be used with specimens of different thicknesses or different types.

2,600,954. Machine for the manufacture and delivery of parallelepipedal paperboard boxes. Gérard Bardet, Paris, France. Filed June 30, 1949. 5 claims. (Cl. 93-44.1.) A turret-type box-making machine.

2,600,989. Container. Gordon Hammond, assignor to Reynolds Metals Co., Richmond, Va. Filed July 24, 1945. 3 claims. (Cl. 229-62.) A method of forming a container from aluminum foil.

2,601,005. Method of affixing conducting tap straps to a paper mounting strip. Edwin A. Raney, assignor to General Electric Co., Schenectady, N. Y. Filed Sept. 17, 1949. 1 claim. (Cl. 154-80.) See also 2,600,322.

2,601,110. Pulping lignocellulose with sodium aluminate. John H. Fischer and Bruce R. Mead, assignors to The Ontario Paper Co., Ltd., Thorold, Ontario, Canada. Filed June 14, 1945. 2 claims. (Cl. 92-9.) Chips are digested with an aqueous solution containing 2 to 15% of sodium aluminate for 2.5 to 3 hours at 185 to 200°C.

2,601,114. Paperboard product and process for making same. Wilbur F. Gillespie, assignor to Gaylord Container Corp., St. Louis, Mo. Filed Jan. 8, 1949. 6 claims. (Cl. 154-100.) The filler sheet is rosin sized, whereas the liner sheets contain in addition a water- and abrasion-resistant resin.

June 24, 1952

2,601,261. Angularly adjustable feed rolls for log peeling or rossing machines. Robert J. Carpenter, West Enterprise, Miss. Filed Aug. 3, 1950. 3 claims. (Cl. 144-246.)

2,601,355. Apparatus for impregnating pourable material such as chips, shavings, and fibrous material. Oswald F. Wyss, Zurich, Switzerland, and Hans Peter; said Peter assignor to said Wyss. Filed Oct. 10, 1950. 3 claims. (Cl. 118-56.) The apparatus consists of a horizontal drum, a rotary rake device, and means for applying a mist of impregnating agent.

2,601,378. Apparatus for extracting water from webs of pulp or paper. James W. W. Evans, Clifton, England. Filed Jan. 31, 1947. 5 claims. (Cl. 92-52.) A traveling, grooved, perforated, continuous rubber belt supports the wire in the region of an open-top stationary suction box; a deckle is located in at least one end of the box and is designed to control the suction applied to the adjacent edge of the belt.

2,601,399. Dispensing milk container. John P. Jones, assignor to Dairy Specialties, Inc., Omaha, Neb. Filed May 21, 1945. 3 claims. (Cl. 222-482.) A milk and cream separating container of the waxed paper type.

2,601,408. Two-step digestion of wood with aliphatic acid. Mervin E. Martin and Daniel L. Sherk, assignors to Celanese Corp. of America, New York, N. Y. Filed Aug. 29, 1947. 5 claims. (Cl. 92-9.) Wood pulp is digested with a 50 to 70% solution of an aliphatic acid (acetic, propionic, or butyric) containing 0.5 to 1% of phosphoric acid for 5 to 60 minutes at 150 to 160°C. and the treated material is further digested with a 30 to 40% solution of the acid containing 0.5 to 1% of phosphoric acid; the purified product is suitable for the manufacture of cellulose derivatives.

2,601,481. Means for opening and loading carton blanks on the conveyor of a packaging machine. Victor G. Williams, assignor to Delamere & Williams Co. Ltd., Toronto, Canada. Filed Feb. 28, 1949. 6 claims. (Cl. 93-53.)

2,601,502. Carrier apparatus for paper driers. Theodore L. Coleman, Hutchinson, Kan. Filed Feb. 4, 1950. 5 claims. (Cl. 34-120.)

2,601,530. Envelope. Albert I. Kegan and Wayne A. Neely, assignors to Samuel W. Kipnis, Chicago, Ill., trustee. Filed Oct. 23, 1947. 9 claims. (Cl. 229-72.) A mailing sheet adapted to be used for two-way shipment.

2,601,568. Closure for flexible tubing. Paul Sussenbach and Clem J. Young, assignors to The Presstite Engineering Co.,

St. Louis, Mo. Filed Feb. 18, 1948. 2 claims. (Cl. 229-65.) A closure for a cylindrical container.

2,601,597. Application of dispersed coating materials to cellulosic fibers. John H. Daniel, Jr., Lucius H. Wilson, Randall Hastings, and Chester G. Landes, assignors to American Cyanamid Co., New York, N. Y. Filed Sept. 6, 1946. 7 claims. (Cl. 92-21.) A method is described for impregnating cellulosic fibers (0.5 to 6% consistency) with a hydrophilic cationic alkylenepolyamine-epichlorhydrin resin and depositing a substantial proportion of the impregnating agent uniformly on the fibers; the freeness and felting properties of the pulp are retained and the resulting paper has high wet strength.

2,601,598. Application of dispersed materials to cellulosic fibers. John H. Daniels, Jr., Lucius H. Wilson, Randall Hastings and Chester G. Landes, assignors to American Cyanamid Co., New York, N. Y. Filed Dec. 26, 1947. 4 claims. (Cl. 92-21.) A method is described for the preparation of wet-strength paper by impregnating the pulp with a partially polymerized cationic urea-formaldehyde polyfunctional organic nitrogen base resin.

2,601,665. Thermosetting resins and process of preparing same. George E. Niles, assignor to Monsanto Chemical Co., St. Louis, Mo. Filed Oct. 29, 1949. 20 claims. (Cl. 92-21.) A wet-strength resin suitable as a beater additive is formed from one mole of urea., 2.5 moles of formaldehyde, and 0.065 mole of sodium 2-naphthol-3,6-disulphonate; the preparation of the resin is described.

2,601,671. Resin-impregnated leather board. Lucius H. Wilson and Charles S. Maxwell, assignors to American Cyanamid Co., New York, N. Y. Filed Oct. 23, 1946. 2 claims. (Cl. 92-21.) An aqueous suspension containing a major proportion of leather fibers is treated with a cationic melamine-formaldehyde resin.

Trend of the Pulp and Paper Market

At its annual session held in Paris from June 16 to 19, 1952, the O.E.E.C. Pulp and Paper Committee considered the trend of the pulp and paper market.

ACHIEVEMENTS IN 1951

When examining the statistics relating to achievements in 1951 the committee noted that, for the first time since the setting up of the organization and despite the difficulties encountered, the paper industry in member countries had succeeded in raising the production of paper and board to over 10 million tons.

The committee noted that a total of 10,228,000 tons of paper and paperboard had been produced, thus enabling the paper industry to meet at least partly the sometimes urgent requirements of its customers both in Europe and overseas.

The factors contributing to this development included the following: (1) an increase in wood pulp availabilities of 18% over 1950, obtained both by an increase in European production and by an increase in imports of wood pulp and pulpwood from nonmember countries; (2) intensified recuperation of wastepaper (33% more than in 1950); (3) an increase of 5% as compared with 1950 in availabilities of other fibrous materials for the manufacture of paper and board (straw, alpha, etc.).

The summary tables give a balance sheet for each category of products for the years 1949, 1950, and 1951.

TREND OF THE MARKET DURING THE FIRST HALF OF 1952

After reviewing the achievements of 1951, the committee proceeded to an exchange of views on the recent trend of the market and future prospects. It noted that the change taking place in the market was each day becoming more marked and might lead to a sharp reversal of the situation to the detriment of the pulp and paper industry as a whole in member countries.

By the end of 1951, a decline in demand in the United States had already been noted which had led to increased

Table I. Mechanical Pulp
Unit: 1000 Metric Tons

	1949	1950	1951	Index 1949 = 100 1950	1951
Production in member countries	2051	2306	2684	112	131
Imports from nonmember countries (total)	137	165	236	120	172
Exports to nonmember countries (total)	27	36	46	133	170
Availabilities (1+2−3)	2161	2435	2874	113	133
Consumption in member countries	2268	2468	2865	109	126
Trade between member countries based on:					
Import returns	521	603	616	116	118
Export returns	525	570	595	109	113
Change in stocks	−83	−1	+30	...	...

Table II. Kraft Pulp
Unit: 1000 Metric Tons

	1949	1950	1951	Index 1949 = 100 1950	1951
Production in member countries	945	982	1064	104	113
Imports from nonmember countries (total)	252	257	321	102	127
Exports to nonmember countries (total)	172	173	133	100	77
Availabilities (1+2−3)	1025	1066	1252	104	122
Consumption in member countries	1037	1168	1228	113	118
Trade between member countries, based on:					
Import returns	317	330	329	104	104
Export returns	288	294	308	102	107
Change in stocks	+17	−66	+45	...	...

Table III. Other Wood Pulp for the Manufacture of Paper and Board
Unit: 1000 Metric Tons

	1949	1950	1951	Index 1949 = 100 1950	1951
Production in member countries	2151	2501	2665	116	124
Imports from nonmember countries (total)	442	435	608	98	138
Exports to nonmember countries (total)	423	478	365	113	86
Availabilities (1+2−3)	2171	2458	2908	113	134
Consumption in member countries	2149	2500	2760	116	128
Trade between member countries, based on:					
Import returns	587	731	763	125	130
Export returns	621	803	779	129	125
Change in stocks	−12	−114	+133	...	...

Table IV. Dissolving Pulp
Unit: 1000 Metric Tons

	1949	1950	1951	Index 1949 = 100 1950	1951
Production in member countries	585	673	807	115	160
Imports from nonmember countries (total)	87	79	127	91	146
Exports to nonmember countries (total)	93	97	85	104	91
Availabilities (1+2−3)	579	655	849	113	147
Consumption in member countries	596	736	848	123	142
Trade between member countries, based on:					
Import returns	309	378	438	122	142
Export returns	312	375	444	120	142
Change in stocks	−19	−77	−5	...	...

American offers in Europe. Moreover, recent recollection of the supply difficulties encountered at the beginning of the raw materials race had led the whole industry and trade, from the paper and board producer to the retailer, to build up stocks during 1951. Consumers at all stages of distribution were, therefore, in a position to pursue a highly conservative purchase policy. Apart from these reasons relating only to the paper trade, France and the United Kingdom encountered financial difficulties which led their governments to impose severe import restrictions.

In order to ensure a maximum supply of pulp for their industries and considering that the quantitative position of the pulp market no longer justified such high prices, the importing countries jointly endeavored to bring about a reduction in prices. After informing the exporting countries at the 14th session of the critical position of their balance of payments, the French and United Kingdom governments imposed ceiling prices on imported pulp while the industry in the other importing countries undertook to apply the same prices without, however, laying down ceilings.

This caused prices in the pulp market to fall by about 20%, followed, at the end of May, 1952, by a further reduction of about 20% in the price of chemical pulp. It was not long before the typical consequence of any downward trend in prices, i.e., a general falling off in purchases, made itself felt. It began with the retailer and then spread rapidly throughout the whole paper and board industry, which was now faced

Table V. Total Wood Pulp for the Manufacture of Paper and Board (Dissolving Pulp Excluded)

Unit: 1000 Metric Tons

	1949	1950	1951	Index 1949 = 100 1950	1951
Production in member countries	5149	5789	6413	112	125
Imports from nonmember countries (total)	834	857	1165	103	140
Exports to nonmember countries (total)	623	687	544	110	87
Availabilities (1+2−3)	5363	5959	7034	111	131
Consumption in member countries	5454	6136	6853	113	126
Trade between member countries, based on:					
Import returns	1424	1664	1708	117	120
Export returns	1407	1666	1682	118	120
Change in stocks	−78	−181	+209	...	...

Table VI. Total Wood Pulp (Including Dissolving Pulp)

Unit: 1000 Metric Tons

	1949	1950	1951	Index 1949 = 100 1950	1951
Production in member countries	5734	6462	7221	113	126
Imports from nonmember countries (total)	921	936	1293	102	140
Exports to nonmember countries (total)	716	784	629	109	88
Availabilities (1+2−3)	5939	6614	7885	111	133
Consumption in member countries	6050	6872	7700	114	127
Trade between member countries based on:					
Import returns	1733	2042	2147	118	124
Export returns	1719	2041	2127	119	124
Change in stocks	−97	−258	+204	...	...

Table VII. Wastepaper

Unit: 1000 Metric Tons

	1949	1950	1951	Index 1949 = 100 1950	1951
Production in member countries	1846	2152	2880	117	156
Imports from nonmember countries (total)	39	5	30	13	77
Exports to nonmember countries (total)	25	12	9	48	36
Availabilities (1+2−3)	1860	2145	2901	115	156
Consumption in member countries	1812	2164	2742	119	151
Trade between member countries, based on:					
Import returns	59	107	133	181	225
Export returns	69	130	132	188	191
Change in stocks	+38	−43	+160	...	...

Table VIII. Wastepaper Recovery

	1949	1950	1951
Austria			
Quantity	26,100	28,000	41,700
Index	100	107	160
Recovery rate	15%	15%	22%
B.L.E.U.			
Quantity	60,000	65,000	65,000
Index	100	108	108
Recovery rate	19.7%	17.9%	17.6%
Netherlands			
Quantity	92,000	130,000	224,000
Index	100	141	243
Recovery rate	24%	26.1%	43.1%
Denmark			
Quantity	29,000	31,000	35,000
Index	100	107	121
Recovery rate	14.2%	13.1%	15.6%
France			
Quantity	293,000	270,000	388,000
Index	100	92	132
Recovery rate	26.9%	22.7%	25.8%
Ireland			
Quantity	11,840	9,300	13,000
Index	100	79	110
Recovery rate	16.7%	10.8%	13.3%
Italy			
Quantity	110,000	120,000	120,000
Index	100	109	109
Recovery rate	22.9%	23.8%	22.6%
Norway			
Quantity	21,000	20,000	22,600
Index	100	95	108
Recovery rate	12.3%	12%	12.4%
Sweden			
Quantity	97,000	103,000	150,000
Index	100	106	155
Recovery rate	20%	22.8%	28.7%
Switzerland			
Quantity	50,000	60,000	70,000
Index	100	120	140
Recovery rate	23.7%	27.1%	26.1%
United Kingdom			
Quantity	675,000	851,000	1,095,000
Index	100	126	162
Recovery rate	27.4%	27.7%	32.6%
Germany			
Quantity	341,200	419,400	612,700
Index	100	123	180
Recovery rate	25.6%	26.2%	33.3%

Average recovery rate: 1949, 24.6%; 1950, 24.7%; 1951, 29.6%.

Table IX. Other Fibrous Materials

Unit: 1000 Metric Tons

	1949	1950	1951	Index 1949 = 100 1950	1951
Production in member countries	425	539	603	127	142
Esparto imports from D.O.T.	160	132	168	83	105
Imports from nonmember countries (total)	5	1	9	20	180
Exports to nonmember countries (total)	1	1	11	100	1100
Availabilities (1 ÷ 2 − 3)	589	671	769	114	131
Consumption in member countries	576	684	738	119	128
Trade between member countries, based on:					
Import returns	15	16	16	107	107
Export returns	11	15	47	137	427
Change in stocks	÷17	−11	÷10	...	...

with a buyers' strike with the consequent considerable falling off in activity. Production was thus reduced by about 30%, sometimes even more. The delegate for Italy, for example, described the Italian situation as follows: 40 to 50% average fall in price for paper and board; 20% reduction in the production of pulp and paper; 90% reduction of pulp purchases from abroad.

It was quite natural that, faced with such a situation, paper and board manufacturers and, chiefly, the nonintegrated mills, i.e., purchasers of pulp, should ensure their production by drawing on stocks and delay purchases of pulp as long as possible. As the order books of the pulp mills were full, this decline in purchases was not felt immediately. In fact, during the early months of 1952, pulp producers fulfilled outstanding orders without reducing the rate of production.

However, the absence of new orders was now obliging the pulp industry in exporting countries to mark time. These countries hoped that the new ceiling prices imposed by the United Kingdom on May 28, 1952 (stated to be operative till the end of the year) would provide a favorable basis for the conclusion of contracts valid until the end of the year. According to the exporting countries, these hopes did not materialize as the prices proposed by the importers during trade discussions were so low that an agreement seemed impossible.

The continued decline in purchases may have serious consequences. Indeed, a number of pulp mills had already taken steps to reduce output. It was also to be feared that, if producers of market pulp could not find outlets, they might be tempted to concentrate on producing special grades of pulp or even to add new paper production capacity to their pulp mills, a step which would leave less market pulp available for importing countries. This danger was confirmed by events during the last slump period.

The committee agreed unanimously that the continuation of this situation seriously threatened the industry in importing countries and exporting countries alike. It recalled that, in 1949, the buyers' strike resulted in a reduction in pulp production and a fall in stocks. It emphasized that the shortage resulting from this situation was one of the main causes of the spectacular rise in prices which began at the end of 1950.

The statements made by the delegates to the committee showed that the consumption of finished goods in their respective countries had declined. This reduction, however, was not uniform in all categories of products. Some economic sectors such as the textile and other consumer goods industries were now passing through a very difficult period. It was clear that on the one hand, the categories of paper and board most affected were those more or less directly linked with the distribution of these products and on the other, dissolving pulp; the reduction shown in the statistics might well reflect the actual position for these commodities.

This situation—which was likely to persist, even after resumption of activity—prevailed in many sectors of the paper and board converting industry. The excessive cost of paper and board packaging had recently led some users to turn to

Table X. Total Fibrous Materials for the Manufacture of Paper and Board

Unit: 1000 Metric Tons

	1949	1950	1951	Index 1949 = 100 1950	1951
Production in member countries	7619	8736	9,895	115	130
Imports from nonmember countries (total)	901	863	1,204	96	134
Exports to nonmember countries (total)	649	700	565	108	87
Availabilities (1 ÷ 2 − 3)	7871	8899	10,534	113	134
Consumption in member countries	7881	8912	10,114	113	128
Trade between member countries, based on:					
Import returns	1498	1786	2,025	119	135
Export returns	1488	1810	1,850	122	124
Change in stocks	−23	−224	+379	...	...

Table XI. Newsprint

Unit: 1000 Metric Tons

	1949	1950	1951	Index 1949 = 100 1950	1951
Production in member countries	1643	1882	1910	115	116
Imports from nonmember countries (total)	233	162	216	70	93
Exports to nonmember countries (total)	356	381	359	107	101
Availabilities (1 + 2 − 3)	1520	1663	1767	109	116
Consumption in member countries	1503	1723	1755	115	117
Trade between member countries, based on:					
Import returns	141	166	155	118	110
Export returns	141	169	158	120	112
Change in stocks	+17	−63	+8	...	...

Table XII. Kraft Paper and Board

Unit: 1000 Metric Tons

	1949	1950	1951	Index 1949 = 100 1950	1951
Production in member countries	893	1051	1104	118	124
Imports from nonmember countries (total)	51	53	123	104	241
Exports to nonmember countries (total)	82	105	85	128	104
Availabilities (1 + 2 − 3)	862	999	1142	116	132
Consumption in member countries	829	971	1105	117	133
Trade between member countries based on:					
Import returns	98	144	171	147	174
Export returns	126	194	207	154	164
Change in stocks	−5	−22	...	...	...

Table XIII. Other Paper and Board

Unit: 1000 Metric Tons

	1949	1950	1951	Index 1949 = 100 1950	1951
Production in member countries	5566	6344	7215	114	130
Imports from nonmember countries (total)	90	118	166	131	184
Exports to nonmember countries (total)	338	349	408	103	121
Availabilities (1 + 2 − 3)	5318	6113	6973	115	131
Consumption in member countries	5170	6013	6865	116	133
Trade between member countries, based on:					
Import returns	346	576	713	166	206
Export returns	392	680	809	173	206
Change in stocks	+102	−4	+11	...	...

Table XIV. Total Paper and Board

Unit: 1000 Metric Tons

	1949	1950	1951	Index 1949 = 100 1950	1951
Production in member countries	8101	9276	10,228	115	126
Imports from nonmember countries (total)	375	333	505	89	135
Exports to nonmember countries (total)	776	835	852	108	110
Availabilities (1 ÷ 2 − 3)	7700	8774	9,881	114	128
Consumption in member countries	7503	8707	9,725	116	130
Trade between member countries based on:					
Import returns	585	886	1,039	151	178
Export returns	660	1043	1,175	158	178
Change in stocks	÷123	−89	+20	...	...

other materials. Apart from the protection given to the packed product, the packaging material was also a valuable publicity medium and users were reluctant to prejudice their products by changing their packaging too frequently. There was, therefore, a risk that, if manufacturers got to know of a type of packaging less subject to price fluctuations than paper and board and offering about the same protection and publicity value they might permanently abandon the use of paper and board, even should the price of the latter once more become advantageous.

On the other hand, the decline in purchases in some sectors was due to consumers wishing to work their stocks down in the hope of being able to buy cheaper at a later date. In such cases, the reduction of consumption was more apparent than real and a resumption of purchases might be expected fairly soon, when the "pipelines" were emptied. For the latter sectors, the greater the number of firms obliged to obtain supplies at any price and the longer the period of reduced production, the greater would be the risk of a sharp reversal of the situation.

It should be remembered that a general reduction of 30% in the rate of production, or its continuance, would mean that the final consumption of paper and board would fall to the 1948 level as shown by the following indices: 1951 = 100, 1950 = 90, 1949 = 78, 1948 = 68.

The committee hoped unanimously that the market would be stabilized as soon as possible in order to eliminate the speculative elements of the present crisis and so that production would reflect the trend of actual consumption. The committee noted that most current offers were at prices about 5% lower than the ceilings fixed in the United Kingdom. The committee considered that this rate seemed in harmony to the prices applied by the United States. These data might warrant the hope that price levels could be reached which would, on the one hand, reflect the general economic trend and, on the other hand, the increase in certain elements of production cost (increase in salaries and ancillary raw materials).

The committee could not suggest practical ways and means of stabilizing the market, but felt that exaggeration in either direction would be avoided if industrial circles were kept more closely and fully informed of market trends.

The Barking of Turkey Oak

R. L. HARVIN, W. J. NOLAN, and WILSON F. BROWN

INFORMATION on the barking of oaks, particularly turkey oak, is necessary if the new developments and processes leading to the use of such wood are to become a reality. The fact that the supply of hardwoods has increased and the softwoods has decreased in the last ten years (*1*) makes it important also that studies be made on the use and handling of the hardwoods.

There is a very meager amount of information in the available literature on the barking of southern hardwoods especially the scrub oaks such as turkey oak, post oak, bluejack oak, and blackjack oak. Calderwood and May (*2*) speak of a mechanized process for separating oak chips and bark in their search for a source of tannin. Much emphasis in the literature has been placed on the hydraulic barking method. This method is applicable when the logs are large enough to warrant its use as in the Northwest. In the Southeast, however, the pine logs are relatively small in diameter and drum barking is generally used. The scrub oaks are small, the average diameter being 6 inches or less (*3*). In addition the scrub oak logs are usually slightly crooked and have a multiplicity of knots.

The present work was undertaken to obtain information on barking where the wood chip suitable for use in papermaking would be obtained. The method used by previous workers (*2*) was probably applicable for obtaining bark from which tannin could be extracted. They used a wood-hog for chipping which gave very small chips only about 20% of which were as large as $^1/_2$ inch. Such small-sized chips are not ordinarily used for making pulp commercially.

Data are in the literature (*3*) on air separation of oak bark and chips. In this case the mixture was placed in sealed moistureproof bags and shipped over a thousand miles before the air separation was attempted. It is believed that working with the raw material under such conditions did not approximate actual commercial operation closely enough.

The percentage or extent of barking of the oak logs will depend to a large extent on the use made of the pulp. It is a well-known fact that there is a low yield of pulp from bark when cooked by the sulphate method. When a pure type of high alpha pulp is desired it is obvious that the barking should be as complete as possible mainly to reduce the dirt count to a very low point. On the other hand, the amount of barking necessary for an unbleached kraft sheet or a hardboard will not be critical as long as the strength is not seriously decreased and appearance is not unduly affected. Keller (*4*) shows that in the neutral sulphite semichemical pulping of slash pine there is a lowering of yield, strength characteristics, and brightness when bark up to 25% was used.

It is not difficult to remove the bark from an oak log during the growing season when the sap is running. It is during this time of the year that the cells of the cambium are swollen with sap and the bark can be removed quite readily by ordinary means. When the cambium cells are quiescent the bark clings tightly and barking becomes more difficult. The bonding strength of the quiet cambium cells is highest from early Fall until Springtime.

The barking of oak logs was tried by two methods on wood cut in November. The barking drum was used wherein the action is principally that of crushing and rubbing causing a fracture to occur between the cambium layer and the wood. Such a fracture can also be obtained with a hammer blow of sufficient force. Likewise when a log is fed to a chipper a similar phenomenon occurs and the bark separates from the wood. This latter method was the second way in which the wood was barked and it resulted in a mixture of bark and wood chips. The problem then was one of separation of the bark from the chips.

The bark obtained in ordinary procedures in the South is burned for its fuel value. Oak bark has been shown (*5*) to have about 10% tannin content which may make it worth while to recover. The drawback previous to this time has been that to obtain tannin from oak bark which is roughly 25% of the tree, there would be left a large amount of wood for which some use must be found. Now that it has been shown that easily bleached pulp may be obtained from oak (*6*) and coupled with the fact that some mills are already pulping oaks in fair quantity, it is possible that the tannin may be extracted from the oak bark with considerable benefit to the mill and the chips can be used for pulp.

EXPERIMENTAL

The species of scrub oak which was used throughout the work was the turkey oak (*Quercus laevis*). This oak is typical of the scrub oaks of this area in that rarely are specimens found larger than 10 to 12 inches in diameter at the base. They are very crooked, have many forks and knots, and they are composed of approximately 25% bark by weight.

Several methods for the separation of the bark from the wood have been tried. These can be divided into two classes: (1) the bark separated from the log, and, (2) the log with

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Table I. Mensuration of Turkey Oak Logs

Log No.	Age, yr.	Average diameter, in.	Average circumference, in.	Weight (5 ft. long), lb.	Bark content, % (O.D.)	Moisture content, wood, %	Moisture content, bark, %	Month wood cut
1	35	6.5	22.5	93	23.6	43.4	26.7	Nov.
2	41	5.5	20.5	71	25.4	43.1	23.9	Nov.
4	68	5.0	18.25	62	23.3	44.0	24.7	Nov.
6	41	5.0	19.25	66	26.6	44.2	24.3	Nov.
7	35	5.0	18.25	63	23.0	43.6	28.3	Nov.
8	40	5.25	20.75	77	25.3	45.8	29.6	Nov.
9	34	5.0	18.0	61	26.3	45.4	29.5	Nov.
10	35	4.25	16.25	50	24.1	44.7	26.3	Nov.
11	35	3.50	15.5	39	28.1	37.3	27.4	Nov.
12	21	2.75	11.0	22	29.9	34.3	26.6	Nov.
13	21	3.75	12.25	34	28.7	41.9	31.0	Nov.
14	22	4.0	13.25	41	23.7	40.3	27.6	Nov.
15	30	3.25	14.0	34	22.3	41.6	27.0	Nov.
18	35	3.75	12.5	30	22.9	40.4	27.3	Nov.
19	34	4.25	15.75	47	27.4	44.3	30.1	Nov.
20	30	3.75	14.75	37	27.7	41.2	28.0	Nov.
21	31	2.25	8.5	13	32.7	43.5	24.8	Nov.
22	..	1.75	6.75	9	..	..	..	Nov.
23	..	2.25	9.25	15	..	..	..	Nov.
24	21	2.75	10.75	23	32.7	..		Nov.
25	40	3.0	13.0	25	30.6	..	..	Nov.
26	31	2.75	11.0	22	31.9	..	..	Nov.
27	..	7.25	27.75	147	..	..	..	Nov.
28	88	9.0	34.0	212	..	..	..	Nov.
29	88	11.5	39.0	261	19.0	47.6	25.1	Nov.
30	88	10.25	36.75	238	18.4	..	..	Nov.
31	53	7.5	27.0	138	21.7	46.4	24.9	Nov.
32	..	8.25	29.75	143	..	..	..	Nov.
33	..	2.5	...	..	24.6	34.1	20.7	June
34	..	3.75	...	..	34.4	42.7	20.7	June
35	..	3.75	...	..	31.9	42.8	19.7	June
36	..	5.25	...	..	28.3	40.3	19.2	June
37	..	5.75	...	..	30.9	47.5	22.2	June
38	..	6.0	...	..	29.1	46.5	20.7	June
39	36	6.5	...	..	33.5	47.5	22.0	June
40	32	4.5	...	..	33.7	46.2	27.7	June
41	40	3.5	...	..	35.4	43.6	21.4	June
42	20	5.0	...	..	22.2	40.2	22.2	June
43	15	...	...	..	40.5	49.4	33.3	June
44	26	..	...	..	38.0	48.0	30.0	June
45	38	...	...	..	32.0	48.4	26.4	June

bark on being chipped followed by separation of the mixture of wood and bark chips. The first of these methods consisted simply of sending the logs through a regular barking drum. The second method involved chipping using a standard chipper followed by separation by screening and by air flotation and combinations of the two.

Use of Barking Drum

In this portion of the work 32 turkey oak logs, approximately 6 feet long, were cut in November. The logs were brought to the laboratory within a few hours after cutting. Five inches were cut off each end of the log and another 2-inch section was also cut, thus leaving the logs 5 feet in length. The 2-inch section was immediately weighed, the bark was removed, and after weighing separately, the bark and wood were put in an oven to dry. This was done to each tree to enabled calculation of the bark content in both green and dry conditions as well as the bark and wood moisture contents. The diameter of each log was measured at both ends and the circumference was measured at the $^1/_4$, $^1/_2$, and $^3/_4$-length points. The age was determined from the dried 2-inch section after sanding the surface. The weight of each log was recorded. These data are shown in Table I along with some additional information collected on wood cut in June.

The logs were divided into four general sizes as determined by diameter, circumference, and weight. Each size was then divided in two parts of approximately equal crookedness, etc. One half of the logs was to be stored for 2 months, the others to be barked immediately. The logs were barked 3 days after cutting in the barking drum of the Palatka mill of the Hudson Pulp and Paper Corp. The drum was running approximately half full of pine logs varying in diameter from 6 to 18 inches and about 5 feet long.

The time for each of the logs to pass through the barking drum was recorded as was a visual estimate of the fraction of bark remaining on the log. With the exception of one small log (no. 22) which broke in half on the first pass, the logs were returned to the same drum for a second barking. Again the time for each log to pass through was recorded. The logs were then returned to the laboratory at Gainesville where the remaining bark was carefully separated from the

Table II. Effect of Barking Drum on Turkey Oak Logs Wood Cut in November—Barking 3 Days After Cutting

Log No.	Time of 1st barking, min.	Estimated bark remaining, fraction	Time of 2nd barking, min.	Total barking time, min.	Actual bark remaining—O.D. basis: Per cent of orig. bark	Actual bark remaining—O.D. basis: Per cent of log to chipper
2	21	$^1/_3$	37	58	0	0
4	21	$^3/_4$	23	44	13.15	3.83
8	20	$^1/_3$	22	42	2.22	0.75
9	26	$^9/_{10}$	22	48	3.67	1.29
13	27	$^1/_{10}$	10	37	2.07	0.83
15	18	$^1/_2$	26	44	2.94	0.84
19	37	$^1/_8$	15	52	1.05	0.40
20	25	...	24	49	0.36	0.14
22	16	$^1/_2$				
23	30	$^1/_2$	30	60	0.16	0.06
26	27	$^2/_3$	18	45	2.86	0.97
27	42	$^1/_4$	32	74	1.83	0.49
30	35	$^2/_3$	15	50	1.94	0.52
31	25	$^2/_3$	20	45	3.10	0.83
				Av.	2.6	0.84

logs, dried, and weighed. The theoretical amount of original bark on each log was calculated from the log weight and the original bark content as determined from the sample cut from each log. The percentage of bark remaining after two passes through the barking drum was calculated. These data are summarized in Table II.

Separation of Bark from Wood by Chipping

Approximately two thirds of a cord of turkey oak logs of varying sizes from 2 to 10 inches in diameter were chipped without prior barking in the 88-inch ten-knife Carthage chipper of the Palatka mill of the Hudson Pulp and Paper Corp. The mixture of wood and bark chips was removed from the conveyor leading away from the chipper and was transported to the laboratory in Gainesville.

Separation of Bark and Wood Chips by Screening

The freshly chipped mixture of wood and bark chips was screened using a No. 32 Day Ro-ball screen with 1 by 2, $^3/_4$, $^1/_2$, and $^1/_4$-inch mesh screens yielding the fractions: -1 by $2 + {}^3/_4$, $-{}^3/_4 + {}^1/_2$, $-{}^1/_2 + {}^1/_4$, $-{}^1/_4$. The weight of each fraction was recorded, and samples of each were obtained. The bark and wood in each sample were separated, and the weight of each was recorded. These samples were dried and weighed again. The percentage of original material in each screen fraction was calculated on the oven-dry basis. The bark content of each fraction was determined on the dry basis as a percentage of the fraction, a percentage of the original mixture, and a percentage of the original bark in the mixture. These data are presented in Table III.

Table III. Screening Bark and Wood Chips—Turkey Oak

Size fraction	*% Orig. mix.*	*Bark content of fraction* — *%* (O.D.)	*% Orig. mix.* (O.D.)	*% Orig. bark* (O.D.)
Original	100	29.2	29.2	..
$-1 \times 2 + {}^3/_4$	48.4	3.9	1.9	6.5
$-{}^3/_4 + {}^1/_2$	28.9	40.0	11.6	39.7
$-{}^1/_2 + {}^1/_4$	13.4	64.3	8.6	29.5
$-{}^1/_4$	9.3	76.3	7.1	24.3

Separation of Bark and Wood Chips by Air Flotation

The air separation equipment used was a Sutton Steele and Steele air-flotation table, Model BX100, powdered by a 10-hp motor. A dust-exhausting system consists of a cyclone and exhaust fan powered by a 3-hp motor. This equipment is shown in Fig. 1. The mixture of wood and bark chips is fed from the chip storage bin to the left rear corner of the table by a variable speed Jeffrey vibrating feeder, No. 3. The air-flotation table operates on a principle similar to that of the Wilfley table in the mineral industry for the separation of ores of different specific gravity. An air stream passing up through the porous deck tends to float the chips and the vibration of the table imparts forward momentum to them. In addition to this motion which is controlled by the longitudinal pitch of the table, the chips receive a transverse motion depending on the amount of the transverse tilt applied to the table. The result is that the lighter fraction is discharged at the feed end of the table and the heavier fraction drops off at the fan end. The intermediate fraction which is a mixture of bark and wood chips is sent back to the feed hopper and repassed over the table. In the experimental setup used in this work a horizontal conveyor collected the discharge from all three discharge spouts and carried the material to the boot of a bucket elevator. The elevator returned the chips to the chip bin and in doing so remixed the wood and bark. This procedure of re-using the wood and bark mixture allowed considerable time for adjusting the table variables. There are five main adjustments provided. The rate of feed is

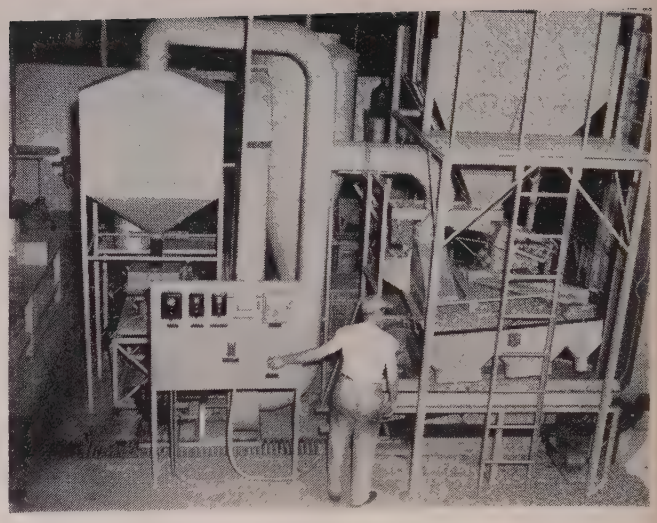

Fig. 1. Air-flotation separator

controlled by the Jeffrey vibrating feeder. The volume of air through the deck is controlled by a gate placed in the suction line. The lateral inclination is controlled by raising or lowering the rear of the deck by elevating screws. The longitudinal inclination is controlled by raising or lowering the heavy fraction end of the deck by means of elevating screws. The speed of oscillation can be varied by adjusting the variable speed drive with the control wheel which is provided. Once suitable operating conditions were obtained, the product streams were sampled for rate and composition determinations.

Separation of the wood and bark chip mixture was attempted using the various screened fractions with the exception of the material held on the 1 by 2-inch screen and the material passing through the $^1/_4$-inch screen. These trials were made using a deck which consisted of hardware cloth covered over with an open weave canvas. The rate, wood content, and dry material contents of the two end fractions are recorded in Table IV. Additional trials were made using a riffled deck which had, in place of the canvas, a series of low metal baffles about $^1/_4$ inch high and 3 inches apart running parallel across the deck in the longitudinal direction. Several tests were run using the $-{}^1/_2$, $+ {}^1/_4$ and $-{}^3/_4 + {}^1/_2$-inch fractions with satisfactory results. The two size fractions were combined giving a fraction designated as $-{}^3/_4 + {}^1/_4$ and the material was run over the table with rate and wood content of the products being determined. These data are presented in Table IV.

In order to simulate the operation of a second air separation of the high wood content product this material was collected and returned to the table after the other material had been removed. The results of this trial are recorded in Table IV.

Since the basis of operation of the air-flotation table, is, according to the manufacturer, the difference in apparent specific gravity of the two materials being separated, this property of the wood and bark was determined in both the green and oven-dry conditions. The mercury displacement method was used for this determination. The results are tabulated in Table V.

DISCUSSION

The barking of wood bolts in a drum barker normally removes most of the bark. The remaining bark is severed from the wood during chipping and a portion of this is removed by the screens. The kraft cooking process dissolves the remaining bark leaving only the dirt which is the most objectional part. The quality of the resulting end product from the pulp will determine the amount of care and work necessary to use in barking of the wood. The work reported

Table IV. Air Separation of Bark and Wood—Turkey Oak

Trial No.	Size fraction	Lower end: Rate in lb. per hr.	Lower end: % of Total output	Lower end: % Wood, O.D. basis	Lower end: % Bark, O.D. basis	Lower end: % Moisture, O.D. basis, wood	Lower end: % Moisture, O.D. basis, bark	Upper end: Rate in lb. per hr.	Upper end: % of Total output	Upper end: % Wood, O.D. basis	Upper end: % Bark, O.D. basis	Upper end: % Moisture, O.D. basis, Wood	Upper end: % Moisture, O.D. basis, Bark
		I. Plain Cloth Deck											
1	-1×2 $+^3/_4$	Too large to separate on machine											
2	$-^3/_4$ $+^1/_2$	417	73.3	83.3	16.7	40.6	30.0	152	26.7	75.3	24.7	40.9	28.2
3	$-^1/_2$ $+^1/_4$	324	53.4	65.4	34.6	36.3	26.5	283	46.6	88.1	11.9	39.6	27.5
		II. Ribbed Deck											
4	$-^3/_4$ $+^1/_4$	1008	78.2	95.4	4.6	35.5	23.7	281	21.8	76.7	23.3	34.7	21.7
5	$-^3/_4$ $+^1/_4$	1260	71.5	89.9	10.1	..	..	502	28.5	63.7	36.6	..	..
6	2nd Sep. end product from No. 5	415	63.9	93.7	6.3	..	..	234	36.1	27.3	72.7	..	..

here is not directed toward any particular end product but merely indicates what performance can be expected from the methods tried. It should be pointed that this work is being continued at our laboratory and that this report covers only a portion of the work that is planned.

The essential requirements of any barking procedure are (1) that bark be removed because it is of no particular benefit as far as pulp is concerned, and (2) that bark be removed because of its accompanying dirt which may form specks in the final sheet of paper.

The first of these objectives can be met equally well by any method that removes a sufficient quantity of bark. The second objective depends to some extent on the method of bark removal. That is, in drum barking, in addition to removing bark the ends of the bolts also may be broomed and thus pick up considerable dirt. These ends must be removed, where dirt is a factor, and can amount to as much as a 10% loss in wood. By utilizing the action of the chipper to sever the bark from the wood practically all of the wood can be recovered in a clean condition. This method could be utilized if satisfactory methods of separation of the bark and wood chips could be found.

Examination of the scrub oak mensuration data of Table I indicates that there is apparently no correlation between age and the measures of diameter, circumference, and weight. On the other hand, the bark content on the dry basis was found to vary with diameter, circumference, and weight in approximately identical patterns. In general, the larger trees had the smaller percentages of bark. The bark content on an oven-dry basis varied between 18.4% for a 10-inch bolt to 35.4% for a 3.5-inch bolt and the mean value was 28.1%. The moisture content of the wood varied randomly between 40 and 48%. The moisture content of the bark varied from 19 to 31% depending perhaps on the recent weather conditions more than any other factor.

At the outset very little definite information was known about the barking of turkey oak except that being a hardwood it was naturally hard to bark. Consideration of the amount of bark and the high degree of crookedness also led to doubt that the conventional means of barking would be satisfactory. From time to time samples of this wood had been secured to obtain the wood chips for other work at this laboratory. During various attempts to bark the logs in a drum it was noted that it was difficult but since the particular investigation did not involve barking, the exact data are lacking. In one such trial several logs cut in January were barked within 3 days. In one pass through the drum, which took approximately 20 minutes, very little barking was accomplished, only one having as much as a third of the bark removed. The seven center logs of Fig. 2 show their condition as they emerged from the drum. The two outer logs in the figure are logs that have not been barked. In another trial four logs which had been cut in June were barked within 3 days. One showed only 25% bark removal after one pass through the drum which was about 20 minutes while another was completely barked in one pass of about 1 hour. The others showed intermediate results. In another trial four logs cut in June came out clean after one pass, but no further data are available.

In the tests carried out in this work, the results of which are in Table II, the logs were about 50% barked after one pass which took an average of 26 minutes. The condition of the logs varied from 10% of the bark remaining to 90% and the retention times varied from 16 to 42 minutes. There was only slight correlation between the retention time and the degree of barking. During the second pass through the barking drum the logs stayed an average of 23 minutes and had an average of 2.6% of the original bark remaining. The condition of the logs varied from 0 to 13.15% of the original bark remaining and the retention time varied from 10 to 37 minutes. The total time averaged 50 minutes. Again there is a slight correlation between the total time of barking and the final percentage of original bark remaining. It is noted that the logs that had less than 2% of the original bark remaining had been in the drum greater than 49 minutes while those with more bark had had less than 49 minutes' barking. It was observed that the one log with 13% of the original bark remaining (no. 4) was not unusual in shape or size and that the bark could be removed with relative ease. It is speculated that a very few more minutes' barking would have removed the bark.

The per cent of bark in the wood going to the chipper is of more importance to value of the process for mill operation. These values range from 0 to 3.8% with an average value of 0.84% bark in the logs to be chipped. This could be accomplished in a mill without the aid of extra hand cleaning but with inspection for return to the drum where necessary. It is again pointed out that the logs were debarked within 3 days after cutting. Even though this work was done in November the conditions used here were favorable to drum barking. Logs are now in storage for further barking tests which will show the effect of aging on the drum barking.

Table V. Apparent Specific Gravity—Moisture Content Data on Turkey Oak

Material	Condition	Moisture content (O.D.), %	Average apparent sp. gr.
Wood	Green	48.0	0.95
Wood	Dry	0	0.652
Bark	Green	30.0	0.825
Bark	Dry	0	0.808

Fig. 2. Logs cut in January, 1951—before and after one pass through barking drum

Another factor in these barking experiments is that the barking was done in the presence of straight pine logs. The exact effect of the crooked oak being barked in the presence of the straight pine is not known but it is felt that the drum filled with all oak would be a factor in favor of better barking.

The results of chipping the log with the bark on are shown in the screening data of Table III. Approximately half of the chipped material was retained on the $^3/_4$-inch screen and less than 10% was passed by the $^1/_4$-inch screen representing material too fine to cook. The bark content of the screened fractions $-1 \times 2 + ^3/_4$, $-^3/_4 + ^1/_2$, $-^1/_2 + ^1/_4$, and $-^1/_4$ were on the dry basis, 3.9, 40.0, 64.3, and 76.3, respectively. The original material contained 29.2% bark. On the basis of the original mixture the various fractions contained 1.9, 11.6, 8.6, and 7.1% bark. That is, in the case of the -1 by $2 + ^3/_4$ fraction for 100 pounds of original mixture there would be 1.9% or 1.9 pounds of bark in the fraction. The distribution of the bark as a percentage of original bark shows that only 6.5% of the total amount of original bark is held on the $^3/_4$ screen while 39.7, 29.5, and 24.3% of the original bark was contained in the $-^3/_4 + ^1/_2$, $-^1/_2 + ^1/_4$, $-^1/_4$ fractions, respectively. In discarding the material too fine to cook ($-^1/_4$ fraction) 24.3% of the original bark is also discarded. Of the original bark 69.2% is contained in the $-^3/_4 + ^1/_4$ range.

A number of trials were made on the air-flotation equipment, using green wood. Other trials were made for completeness of data on dried material.

Investigation was made of the effect on apparent gravity of moisture in the wood and bark. The apparent gravity was determined by the mercury method on the dry material and on the green material. It was noted that the bark showed only a slight increase in apparent gravity with moisture of 30% while that of the wood showed a wide deviation from dry to 48% moisture. When dry, the wood is lighter than the bark whereas wood with 48% moisture is much heavier than bark with 30% moisture.

It was considered at first that the apparent gravity was the prime factor in air separation. Inspection of results showed that this is only partially true and that the shape factor and the weight per unit area are probably the real controlling factors. Wood when chipped tends to split along the growth rings into chip form about $^1/_4$ inch thick on the average. Bark, on the other hand, does not split like the wood and is recovered in more or less lumpy form. When the mixture is run over the air-floation table a majority of the bark is recovered at the high or heavy end regardless of whether it is dry or green. The wood chips lie flat on the screen thereby exposing their largest area while the bark being in the form of a rounded lump exposes a much smaller proportion of its area. The results show that even though the apparent gravity of the bark is less than that of the wood, probably because the machine moves the bark toward the heavy end, the weight per unit area is greater.

There are several points about the operation of the air-flotation machine that should be noted. Of all the adjustments on the machine the volume of air is the only one that is anywhere near critical. The air opening should be adjusted so that it will float the material but should not blow it off the table. The rate of feed should be the maximum possible keeping the table full at all times. It was noticed that at half load separation was not very good.

The output rate at both the wood and bark ends was determined by catching the product in a container for a definite period of time usually 5 or 10 minutes and then weighing. The rate per hour was then calculated.

The size of the chip has a direct effect on separation. It was found difficult to air separate chips of $^3/_4$ inch or larger. On the other hand, it was not difficult to separate anything that passed through $^3/_4$-in. mesh. Therefore prior screening is necessary.

The rate of feed is important in that sufficient material must be present on the table to cover it. The depth of the bed is not critical but it is obvious that the rate of feed should be the maximum possible consistent with the conditions.

The air separation of bark and chips was suggested previously (*2*), and that work was pointed toward obtaining the oak bark from which tannin can be extracted. Their chips were made in a Mitts and Merrill hog and about 49% passed through a $^1/_4$-inch mesh screen. The material used in this work was chipped in a regular size mill chipper and 9.3% passed through a $^1/_4$-inch mesh screen. The work done on air separation of bark and chips holds such promise that a more detailed study of this method will be made. It has been noticed that the bark tends to concentrate in the middle fraction which is usually returned for further separation and this may point the way toward a better separation. A factory-size chipper will be installed in the laboratory which will allow numerous trials to be made more easily.

CONCLUSIONS

1. Drum barking was found to be a satisfactory method of bark removal for turkey oak under the conditions of the experiments.
2. The time required for drum barking of turkey oak was found to be two to three times that required normally for southern pine.
3. Screening of the material obtained by chipping the turkey oak logs with the bark still on, removed some bark but was not sufficient in itself.
4. Air separation of the material obtained from the screening of the chipped turkey oak logs with the bark still on gave a product containing approximately 5% bark.

LITERATURE CITED

1. Forest Statistics for Florida, 1949, U.S.D.A. Forest Service, Southeastern Forest Experiment Station, Asheville, N. C.
2. Calderwood, H. N., and May, W. D., Florida Scrub Oak—New Source of Vegetable Tannin, *Hide and Leather and Shoes* (June 8, 1946).
3. Calderwood, H. N., and May, W. D., Scrub Oak as a Potential Replacement for Chestnut, *J. Am. Leather Chemists Assoc.* 42, No. 2 (Feb., 1947).
4. Keller, E. L., Effect of Bark in the Neutral Sulphite Semi-chemical Pulping of Aspen, Hickory, and Slash Pine, *Tappi* 33, No. 11 (Nov. 1950).
5. Rogers, J. S., Calderwood, H. N., and Beebe, C. W., Study of the Tannin Contents of Barks from the Florida Scrub Oaks, Technical Paper Series, No. 56, Florida Engineering and Industrial Experiment Station.
6. Harvin, R. L., Hills, G. B., Jr., Rothrock, C. W., Jr., and Nolan, W. J., *Tappi* 33, No. 7 (July, 1950).

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The Nature of Odor

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Odor is one of the facts of life; of great importance to all of us but not often appreciated for what it is. We all use the sense of smell every day, but only a few of us use it knowingly and to full advantage. In former times the senses of smell and sight were used to identify food items as safe to eat, or otherwise, based on our past experiences. Nowadays, with the food and drug laws working for our welfare and with the quality of food high through rapid transportation and refrigeration, the function of odor is less for our protection. We can now turn to it for enjoyment.

Aroma is the most important sensory element of food. We can't get very far from food and flavor even though we're talking paper. Whereas there are only four tastes, sweet, sour salty, and bitter, there are thousands and thousands of separately distinguishable odors. It is almost a parallel to saying that you may know thousands of people but you can tell each one from the other by his face, his voice, and many other characteristics. A person who is acquainted with odors can tell each from the other. There is as much individuality to an odor as there is to a person. Nearly all flavor discrimination is done through odor rather than through taste. That seems peculiar, but actually it saves many pounds on your waist measure when you are working on food problems: if you can tell by smell most of what you need to know about food, you need not eat a great deal of it.

Figure 1 shows an analysis of the general operation of sensing. A stimulant acts on a sense organ to produce a sensation. A stimulant such as the seasoning salt acts on the taste buds of the tongue to produce the taste of salt. An odorant such as oil of lemon acts on the detecting area in the nose to produce the smell of lemon. Certain irritants such as pepper act on the membranes of the throat to produce the feeling of pain. It seems strange that we should want a feeling of pain. Actually it helps to point up a mass of otherwise dull flavoring. These three senses—taste, smell, and feeling—are the principal ones used in connection with the flavor of food. To be sure, we taste first with our eyes. The food has to look right, to look as though it is clean and fit

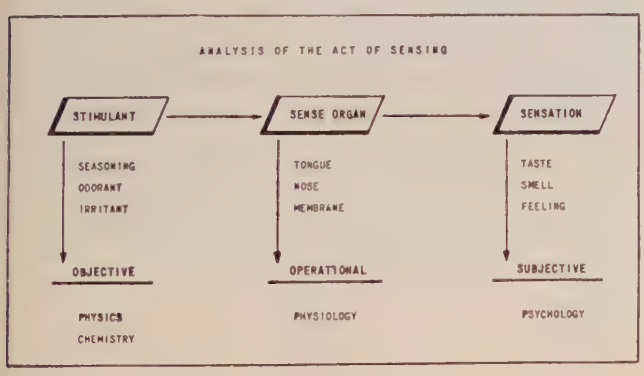

Fig. 1

to eat. Having assured ourselves of the appearance, then we appraise by the two chemical senses, taste and smell, and to some extent by feeling. Once in a while with certain cereals, we may have sound effects.

Stimuli are purely objective. They are mostly solid and liquid substances dealt with by physics and chemistry. The sensing, or the operation which happens when the stimulant works on a sense organ, is just not known. But this we do know, that when a stimulant acts on a sense organ it sends action currents to the brain, and up at the switchboard in the brain the sensation is produced. Up to the point between sense organ and sensation (see Fig. 1), the action currents are still objective realities. They can be amplified and made to operate loud speakers and other electrical devices. We call this action operational and it's in the domain of the physiologist. Sensation is subjective. Nobody can touch or measure anything that is subjective. Sensation is unique for any particular person. It is dealt with by the psychologist.

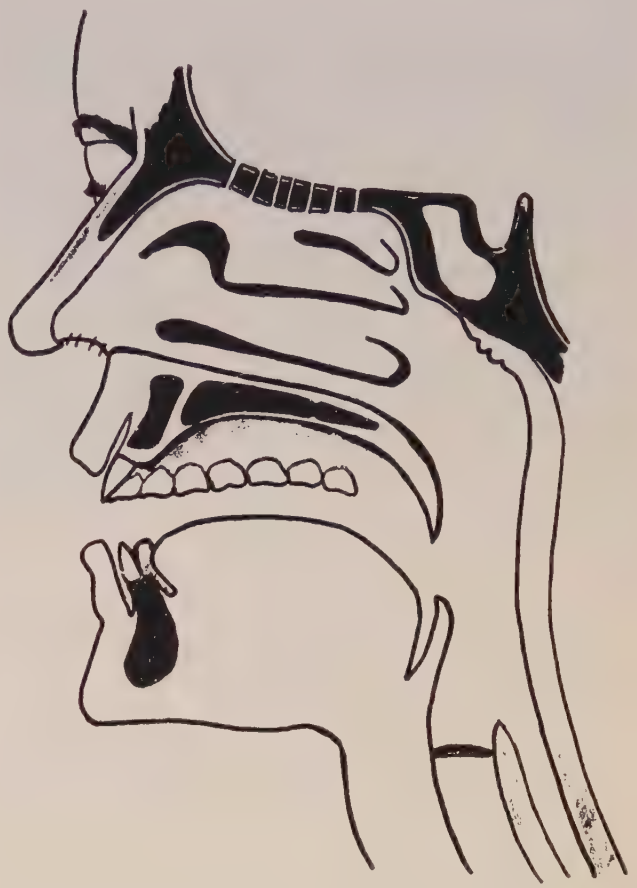

Fig. 2. Cross section of the human head showing air passages and smelling and tasting areas. Smelling area is enlarged. Dark areas indicate bone

As far as sensation is concerned, we all have to be psychologists. One of the interesting changes that has taken place in work on flavor in recent times is the realization that one has to become a psychologist as well as a physicist or chemist. If a thing is subjective, what are you going to do with it? Is it any good? It happens that the same stimulus applied to a great many people seems to produce just about the same sensation in all. Therefore, since sensation is repeatable, it has a certain degree of objectivity and the term "objective-subjective" has come into use for describing sensation.

Figure 2 is a cross section of the human head. It is in a sense a cartoon because it isn't an accurate section. The area where smelling is done is magnified nearly tenfold. The smelling nerves go through the perforations of the cribriform plate (at the top) up into the brain's olfactory lobe where amplification takes place. The so-called turbinates or horizontal baffles, are turned and twisted in various ways. These baffles deflect the air that we breathe. Most of the air travels through the lower passages into the windpipe. Very little gets into the more tortuous path over the upper baffle because of the high resistance. Therefore, in ordinary breathing we do not sense the odoriferous molecules dispersed in the air.

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We are quite unconscious that an odorant is present. A bit of dispersion takes place, and a few of the molecules reach the smelling area, especially if it happens to be a strong odor. But unless you learn to "sniff," to raise the air strongly and even audibly, you can't smell. In taking a strong sniff the air is thrown rather violently up to the smelling area. One difference between a smeller and a nonsmeller is the learning to sniff. It can be done gracefully and it can become a way of life. A great deal more of life will be available to you if

Fig. 3. Water-soaking test for paper odor investigation

(From "Paper-Package Odors," by L. B. Sjöström, *Modern Packaging* 23, No. 12: 118 (Dec., 1950).)

you do it. Take a little sniff every once in a while. Do it consciously until you can do it by second nature and you will learn a great deal by it.

When food is eaten, it goes through a mill, gets chewed up and mixed with moisture, and is warmed. Whatever odoriferous material there is in it gets loosened up during the commotion and the warming and moistening and at the moment of swallowing a puff of the scented air is sent upward so that you are able to smell it.

If you eat either onions or garlic and brush your teeth to remove any particles and rinse your mouth with a gargle of some kind, no one can detect onions or garlic on your breath for 20 to 30 min. Then, it may be on your breath for 24 or more hours; after the food gets down to the stomach, the odoriferous materials pass into the blood stream. The only way they can get out of the blood stream is through airing, by way of the lungs. So your breath, after that first 20 to 30 min., will carry the odor out. We really have three lungs—there's one on each side and then the skin of the entire outer surface of your body is about equivalent to a third lung. You not only air out the blood through the lungs, but odor exudes from your whole exterior after you have eaten certain kinds of food. It isn't limited to simply onions and garlic, but includes quite a few different kinds of meat, as lamb and chicken.

A lot of foods, especially fatty foods such as nuts and fried foods in general, may not have appreciable odor if sniffed by the front of your nose, but you can smell them at the moment of swallowing quite well. It's part of the flavor which you don't think of as odor; but when you stop and consider, the temperature in the mouth is nearly 100°F. and the temperature outside is only about 70°. That extra 30° of temperature favors greatly the smelling of things. You are able to smell an odor of only a fourth or fifth as much intensity by the back route as you can by the front route.

Every container for food, including paper boxes and wrappings, must contribute nothing to damage the aroma (*3*). In theory, paper is cellulose, an odorless material. In practice, we know better. Let us consider paper contamination as we review the general subject of flavor, and, in plain words, it's always paper contamination rather than actual paper odor.

Table 1. Typical Off-Odors Found in Paper Products and Their Sources

Classification	*Source*
Industrial chemicals	Chlorine, hypochlorite, phenol, ozone
Oils	Fuel oil, gasoline, kerosene rancid fat, soap, carbon paper, inks, varnishes
Mustiness	Algae, musty stock, musty water, partially degraded sizing
Perfume	Perfumed stock, sweeping compound, coating perfume
Nonperfume aromatics (mercaptans) (amines) (sourness)	Garbage, residues in used stock, adhesives

From "Paper-Package Odors" by L. B. Sjöström, *Modern Packaging* 23, No. 12: 118 (Dec., 1950).

Table I shows typical off-odors found in paper products and their sources, including certain industrial chemicals and oils such as chlorine, hypochlorite, phenol, oils, fuel oil, gasoline, kerosene, rancid fats, soap, carbon paper, paints, and varnishes (*5*). Paper meets almost everything in one way or another, and mustiness can happen through algae, or musty stock which had fermentation or mold growth at some earlier stages. Musty water, partially degraded sizing, and perfumes may be used unconsciously or otherwise, sometimes in the form of masking agents and sometimes accidentally. Many nonperfumed aromatics such as garbage, residues, used stock, and adhesives may get into the furnish.

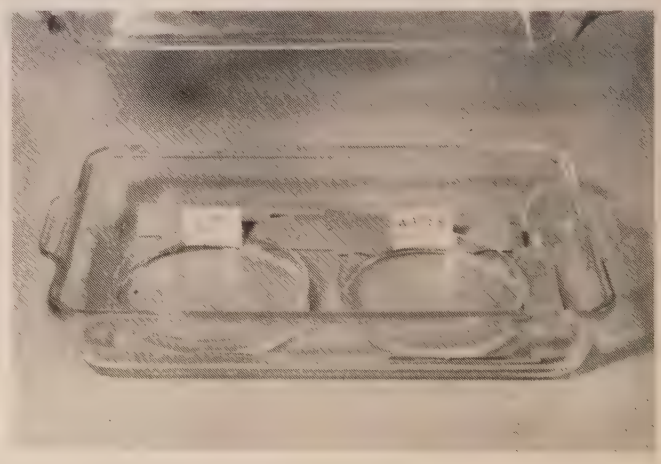

Fig. 4. Strips of food packaging board and Petri dishes of odorless oil and water are held in a covered vessel for 12 to 24 hr. Then the liquids are removed and sniffed for odor pickup

(From "Paper-Package Odors," by L. B. Sjöström, *Modern Packaging* 23, No. 12: 118 (Dec., 1950).)

Figure 3 shows a method for bringing out odor, at least to make odor obvious, where papers are soaked in water and then the water is smelled. It is a very effective way to compare a large number of samples.

Figure 4 shows odor transmission through the air to mineral oil and water in Petri dishes. They are put in the large dish and covered so that they stand where pieces of paperboard can vaporize their odor and the water and oil pick them up. It is rather surprising that sometimes odors will go into water better than they will into oil. At any rate, in about 24 hr.

if there is much aroma in the paper sample enough will have passed into the oil or water so that you can smell it.

Figure 5 shows the method we call the butter sandwich, where a piece of fresh butter is placed between two pieces of cardboard and then covered. Leave it overnight, or better 24 to 48 hr. The flavor doesn't go very deeply, only for a hundredth of an inch or so on each side. Scrape off a thin layer of the butter and eat that.

Figure 6 shows the method of steaming paper with the breath before smelling it. You exhale through the mouth and the moisture condenses on the paper. During the evaporation which immediately follows, you get the odor. This is the process known as "steam distillation."

Taste is sense operative in milligrams, which approximate the size of grains of salt or sugar, and it is caused by materials dissolved in saliva. You rarely have enough soluble material in paperboard to do much tasting. If you want to know if you are doing any true tasting, pinch your nose; if you get the same effect with your nose pinched as with your nose free, then it really is taste and not odor. There are only four clear-cut taste sensations, saltiness and sourness, both of which call for ions, and the nonionic sweetness and bitterness. In general, when paper has an off-taste, it is bitterness, because only rarely is there noticeable sourness or sweetness due to picked-up impurities.

If taste is a milligram sense, then odor is a millionth of a milligram sense. It is almost infinitely more delicate than taste. The question comes, what is odor? We know that it is due to molecules dispersed in the air we breathe. Your nose doesn't seem to be able to get a hold of tiny molecules. They don't produce smell. One of the smallest molecules of all is water, H_2O, with only 18 units of molecular weight. We couldn't smell water because we are adapted to it, even if it had an odor. Even methyl alcohol doesn't have very much odor when it is pure, and formaldehyde doesn't have much true odor, though it has plenty of sting and pungency. The lowest members of almost all chemical series have rela-

Fig. 5. Butter is convenient for picking up paperboard odors. After 24 to 48-hr. contact it is tasted

(From "Paper-Package Odors," by L. B. Sjöström, *Modern Packaging* 23, No. 12: 118 (Dec., 1950).)

tively little odor. On the other hand, when the molecular weight gets up high, there also isn't much odor. There is an optimum molecular weight of compounds that have odors of maximum detectability. Let us ascend a chemical series, such as the aldehyde series. Formaldehyde has relatively little odor; acetaldehyde, a very considerable amount besides the feeling factors, and propionaldehyde, very much more; butyric aldehyde, still more; and valeric aldehyde, about the most intense odor that one can imagine. When you go beyond C-7, C-8, C-9 the odor comes right down in intensity just as it went up, and it comes down not only on the basis of weight of substance in a given quantity of air, but also on the basis of the number of molecules in a sniff. In other words, we get less of a grip on the heavier molecules than we do on the medium-sized ones. We smell strongest or most easily those molecules in the 100 to 300 molecular weight range. In a way, noses are instruments for measuring molecular weight. A nose is a very fine device to carry around with you all the time. It's very handy, takes very little material, and enables one even to detect molecular weight. To a certain extent chemical structure can be detected too, but not quite uniquely

Fig. 6. By steaming paperboard with the breath, the examiner finds its odor much intensified

I have been fooled on two different occasions with an odor that was presented to me and said, "Why, that's camphor." We are all familiar with the ordinary odor of camphor. We know the feeling and the smell that goes with it. It happens that cyclo octane epoxide, which is a very different thing from camphor chemically, has almost identically the same odor. And there is a tertiary butyl alcohol where one of the methyl groups has three chlorines instead of three hydrogens. It too has almost exactly the odor of camphor. Strangely enough, each of these substances, real camphor, cyclo octane epoxide, and the tertiary alcohol not only all smell like camphor, but behave like camphor, in subliming. That is, if you warm them up slowly, they vaporize, and then condense as solids on a cool adjacent glass surface. So apparently odor is partly the result of physical behavior as well as chemical constitution. By and large there is a different odor for every chemical substance.

Odor transfer is a very interesting thing. Odors in the air can be picked up by almost any solid thing. It is similar to dipping a solid into water. You know that if you dip glass or iron or anything else into water there is produced a surface layer of the liquid all over it. In general, it is pretty difficult to keep solid materials from picking up liquids. When you have a solid in scented air, you meet almost the same behavior. Dip a piece of iron or glass or anything else into a beaker of scented air, pull it out, and wave it around in the air for a while, and then smell it; you'll smell the thing that was adsorbed because it doesn't air off easily. Solid materials have a considerable capacity for holding gases, and, of course, all odorants in the air are gases. Why don't the solids hold air instead of the things that have odor? They preferentially hold heavier things, the things that are near their condensing point. The nearer a gasified substance is to the point where it condenses or sublimes, the more strongly solid materials hold on to it. Don't be surprised if pieces of paper in scented atmospheres pick up odors. They don't have to have anything in their mass that is especially attractive to these odors,

such as greases, or even moisture. Ordinary glass picks up odor quite strenuously; it is quite a job to get the odor entirely away from glass when you want to do precise laboratory work.

Sensing is the second part of Figure 1. The first part dealt with stimuli—and very many materials are stimuli. Sensing is an entirely unknown process. Fortunately at the present time two eminent psychologists or groups of psychologists in this country and in England, are trying to bridge that gap. Pfaffman at Brown University is carrying on experimental work on rats and is beginning to get some idea of what happens to the taste buds on the tongue and to the smell area in the nose when they detect tastes or odors. There is still quite a way to go, but they are able to amplify the impulses that come out through the nerves and in that way get some idea of what must be going on at the detection point. A psychologist in England by the name of Adrian is carrying on the good work there.

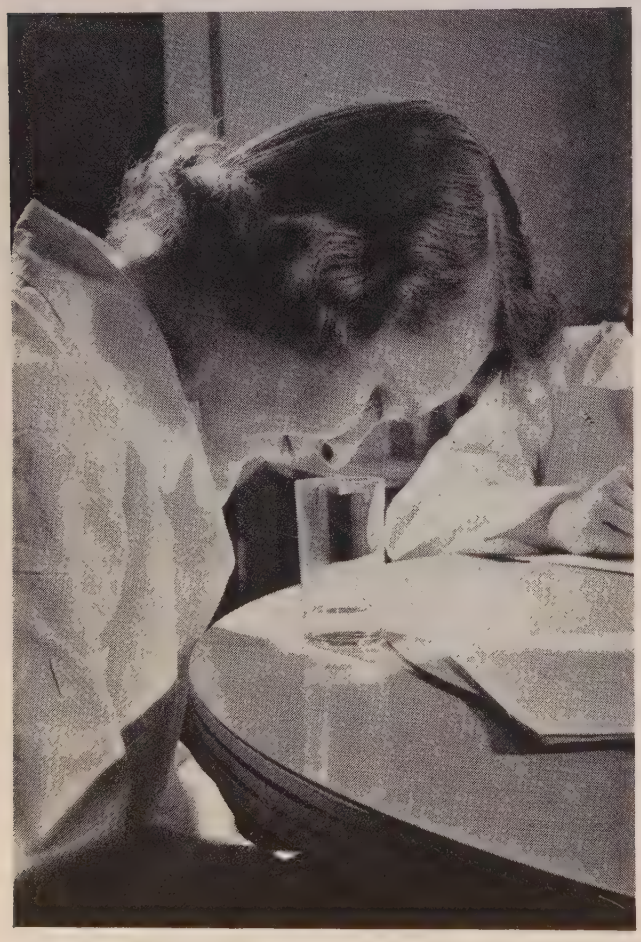

Fig. 7. The approved method of smelling beverages is to use oven-baked glassware with hands far from the glass

(From "Industry's Problem Solvers," by D. Hartwell, *Am. Business* 21, No. 9: 9 (1951).)

There are many practical applications for odor work. One phase is troubleshooting when unwanted odors are present in products. There can be the improvement of existing foods; there can be the commercial appraisal of food quality; there is air deodorizing, so called. There is no true air deodorizing by any means except passing it over active carbon or a few other things such as clay or zinc oxide. Those substances take some of the odor out of air. All solids take some odor out and some are fairly effective for taking most of the odor out, but they tend to miss the lower molecular weight materials. For instance, there isn't any carbon filter that will catch ethyl acetate, or ethyl alcohol, or any of the other low members. Carbon can sometimes pick up 40% of its weight of some of the things that have molecular weight around 200.

There are many odors that you want to remove from air and if you can't take them out by carbon, try various other tricks. Masking is one trick. Here is the psychology behind masking. Any single odor which stands out is like a sore thumb; you can't get rid of it. It is very obvious and noticeable to you. But if you take that very noticeable

Fig. 8. The triangulation test is used to determine if differences are detectable between samples. The author, on the left facing the camera, and other panel members examine samples, preparatory to round-table discussion

thing and mix with it at least one other substance which may be equally noticeable and objectionable, that makes a confusion. When you smell it, you are not sure whether or not you dislike it. By the time you have mixed about three or four things together, even though the odor intensity is actually higher than before, you may not think anything is there.

Figures 7, 8, 9, and 10 show what goes on in a professional flavor laboratory. At Arthur D. Little, Inc., in Cambridge we have a flavor laboratory, one of the first in the country, with about 40 workers. I want to show you some scenes within the laboratory.

How to do smelling: don't hold something up to your nose using your hands. In Fig. 7 beer is being smelled, and the glass had to be very carefully prepared before it was done. It was washed with a detergent, rinsed very carefully with hot water, and dried in an oven. This procedure prevented any odor from clinging to its surface. A little beer was poured into the glass and the hands were kept away so the taster could get the aroma of the beer itself apart from anything else. If one didn't properly clean the glassware, the glass would smell chalky and that would interfere with odor analysis.

Figure 8 shows two operations going on in a panel room. First is a round-table discussion and a testing of the testers. This is the so-called triangular test (*4*), using in this instance, strawberry jam. Two of the samples are absolutely identical, out of the same jar, and the other one is out of another jar with enough difference so that most people should be able to detect it when their attention is called to it. If on a particular morning you come in and want to know whether you should taste on that day, you take this triangular test. If you can't find the odd one among the three, you had better not smell for a living that day, or at least that half day. On very fussy work we may have to do three triangular tests in succession to test the testers. The people in the back row are

working on products. You will notice the absence of separations or partitions between them. We find that the best work in tasting or smelling is done under as nearly as possible home conditions, without the artificiality of booths. There is such a temptation to judge berries by the color that you can hardly get a fair answer if the tasters see the color. So we use red lights for that work. With it a greenish berry looks just the same as a red ripe berry. Then the tasters really have to use their noses. It is a little harder to use the nose than it is to look at a specimen.

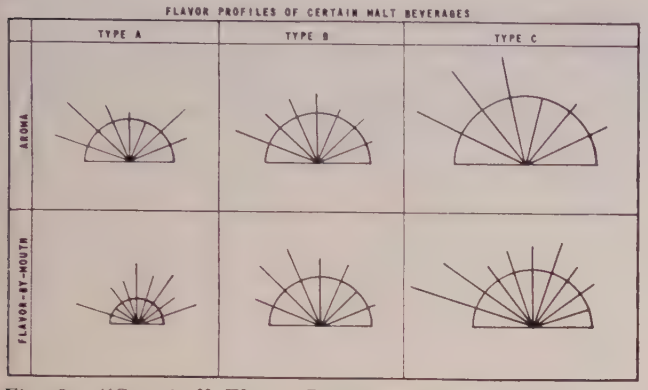

Fig. 9. "Sunrise" Flavor Profiles picture findings. The beverages are ale, bock beer, and stout

(From "The Evolution of the Profile Method for Analyzing the Flavor of Beer," by E. C. Crocker, presented at the 44th Annual Convention of the Master Brewers Association of America, Detroit, Sept. 26, 1951.)

Figure 9 will illustrate one phase of a very effective tool, the Flavor Profile (*1*). One of the men in our laboratory was quite impressed by the personal profiles that are published in the *New Yorker* magazine. One day it occurred to him to see if he couldn't do something like that for flavors. He happened to hold up his hand as he described the flavor of an apple. For the little finger there is the sweetness of taste that goes with every apple; for the next finger there is the sourness of taste; for the middle finger there is the bitterness; and for the index finger astringency. You wouldn't give a nickle, or even one cent, for an apple if it didn't have a certain amount of astringency, and that goes for cider or tea, or most any other beverage. You must have a certain amount of astringency. All the rest of the flavor is odor—aroma. As he was pointing out these different things the other fellow asked him, "What's the palm of your hand for?" He replied, "The palm is all the flavor that you don't notice, those things which are blended so well together that you can't spot the individual notes." The palm is the blended part of the flavor and the fingers are the notes that stick out. A flavor that is perfectly blended is perfectly insipid. You have no use for it. You have to be able to note some things sticking out.

When a draftsman tried to represent the hand, palm and all, on a sheet of paper, he came up with: a semicircle and rays—a sunrise effect. In fact we call this the "sunrise form" of the Flavor Profile. As it is represented, a small circle means low intensity, a large circle high intensity. In general the area of the circle shows the over-all intensity. The notes that stick out are the rays. It is very convenient to consider odor first, and the three semicircular sunrises shown above the lines depict aroma only, and the three below are for flavor-by-mouth, which means aroma plus taste plus mouth-feel. This first one, type A, happens to be ale that is popular in New England. Type B is a bock beer, and type C is a stout. You can see that stout has a perfectly tremendous odor and a pretty strong taste, so much so that it takes somebody raised in the British Isles to like it straight. Around here it is used half and half. If beer is weak for you mix it half and half with stout and the combination can be pretty good. Bock beer has a rather strong aroma and taste but at this season of the year it is somehow appropriate. So far as the New England ale is concerned, this one was a disappointment in some respects. It has a wonderful aroma and almost no taste. It might as well be water. You can see that with a device like this Flavor Profile in the hands of a master brewer, comparing his product in one column with those of several competitors in parallel columns, he can kind of visualize each of the components and say perhaps, "Well, mine has a higher hoppiness and a more moderate acidity than competitor X." Perhaps his competitor's outdoes his on some other factor. But he is able to note what the differences are and be able to *divide* that very complex thing. If flavor is inscrutable, the Profile at least unscrews it. By

A FLAVOR PROFILE REPRESENTING NATIONALLY-DISTRIBUTED TYPE BEERS

AROMA	INTENSITY	AMPLITUDE
Hop fragrance	1-2	2-3
Fruity (apple or grape)	2	
Yeast	1	
Sour	2	
Malt	1	
Hop resin	1	
Phenylacetic acid	1-2	
Skunk	0	
Others	0	

FLAVOR-BY-MOUTH	INTENSITY	AMPLITUDE
Salt	1	2
Sweet	1-2	
Sour	1-2	
Fruity (apple or grape)	2	
Bitter	2	
Yeast	1	
Malt	1	
Phenylacetic acid	1-2	
Skunk	0	
Metallic	)(-1	
Astringent (dry throat)	)(-1	
Others	0	

KEY - 0: not preceptible)(: just recognizable
1: slightly strong 2: moderately strong 3: strong

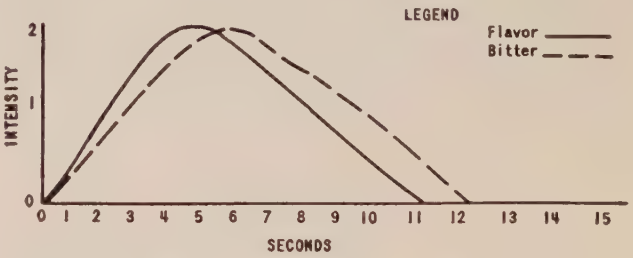

Fig. 10. The tabular form of Flavor Profile is preferred in the laboratory. The curves at the bottom show intensity versus time for one sip

(From "The Evolution of the Profile Method for Analyzing the Flavor of Beer," by E. C. Crocker, presented at the 44th Annual Convention of the Master Brewers Association of America, Detroit, Sept. 26, 1951.)

subdividing the complexity, one is able to detect and work on the individual notes. Most brewmasters are able to alter one component at a time and sometimes two or so at a time, and ultimately, by enough experiment, will find out how to change their beer and make it more acceptable (*2, 6*).

Figure 10 is the tabular form of the Profile, which has as a feature in beverage studies intensity versus time. In the case of a sip of beer, it takes about 5 or 6 sec. before it reaches maximum intensity of taste, and in about 10 or 11 sec., the taste is pretty well gone. That is necessary because if the

taste comes and goes within 5 or 6 sec., it passes so fast that you may say, "What went by?" You haven't time to perceive it. On the other hand, it it's too slow, you say it's cloying. The time has to be between 10 and 15 sec. and all the popular and successful beers and ales do this. You notice a dotted line as well as a full line. That stands for bitterness. Bitterness comes a little slower than the rest of the flavor, and that's intentional. Toward the end only bitterness is perceivable. For several seconds toward the end there is only bitterness and you have to take another sip to wash it away.

I want to mention something that was spoken about to me a little before the meeting—casein coatings. Sometimes a casein coating will smell practically forever on paper; it can continue to give off odor almost throughout its life, and certainly for several years. I recall a case of a coated-paper plant where workers wanted to start off with a bang first thing in the morning, so the foreman had the casein made up the night before so that they were ready to go great guns in the morning. It got by a good deal of the time. But there came a time during the Summer, perhaps a very hot Monday night, and during that time the casein started to ferment. Consequently, most of Tuesday's production, while it may not have had a noticeable odor at the time, developed odor over a long period of time, causing many complaints; the tanks were all contaminated with that bad stuff, all the batches for the rest of the week were bad. Of course, at the end of the week the tanks were steamed out and the contamination was killed. (I hope that the brushes were sterilized.) The trouble was overcome by getting the casein mixer to come in an hour earlier in the morning, and any casein that wasn't finished by night was run down the sewer, and the whole machine cleaned out.

LITERATURE CITED

1. Cairncross, S. E., and Sjöström, L. B., *Food Technology* 4, No. 8: 308–311 (Aug., 1950).
2. Crocker, E. C., *American Brewer* 84, No. 4: 33–37 (Apr., 1951).
3. Deininger, N., *American Baker* 18, No. 12: 26–27 (Dec., 1950).
4. Helm, E., and Trölle, B., "Selection of a Taste Panel," *Wallerstein Laboratories Communications* 9: 181–194 (1946).
5. Sjöström, L. B., *Modern Packaging* 23, No. 12: 118 (Dec., 1950).
6. Swaine, R. L., and Bell, V. P., *Modern Brewery Age* 45, No. 6: 41, 42, 44, 100 (June, 1951); 46, No. 1: 25–26, 91 (July, 1951).

Presented at a meeting of the Chicago Section of the Technical Association of the Pulp and Paper Industry, Chicago, Ill., Mar. 17, 1952.

DISCUSSION

Question: Does a burning candle deodorize air?

Mr. Crocker: No. It will use up some of the air but it doesn't deodorize it. As a matter of fact, attempts to burn odors out of air with gas flames, etc., are singularly ineffective. Passing the smelly air from a kettle of boiling oil through a gas flame in the stack lets most of the odor continue right on through.

Question: What factors influence odor transmission through various sizing papers, films, etc.?

Mr. Crocker: In general, odors go through a packaging material by dissolving in one side, passing through, and evaporating from the other side, so that a solvent for the odoriferous material is transmissible to that odor. Something like cellophane doesn't pass many of the fatty odors because it isn't transmissible to them. There aren't many packaging materials open enough so that odors go through under their own power. Nearly all odors have to dissolve in one place and be evaporated from another in going through.

Question: What causes the objectionable odor found in kraft liner board—the dead cat intensity? Does it ever transfer itself to food?

Mr. Crocker: I'll answer the second part. I don't know what the story is on the dead cat character, but the odor does certainly transfer itself to food. If there is an appreciable odor to paper when you chew it or when you steam it and smell it, that odor will transmit to food pretty surely, and particularly if the package is wrapped in cellophane to keep it from airing out from the outside. If you have a bad smelling paper box with food and then seal it nicely in cellophane you give it every possible chance to pick up the odor. You don't dilute it away in any manner. But I don't know what this dead cat is unless it's simply incompletely rinsed paper. Somebody mentioned today the running of paper very dry and hot. That is certainly a method of clearing out odors as well as you can. There are certain things that are very difficult to drive out, but whenever you have evaporation of water, there is the process of steam distillation by means of which the moisture carries off a great many odors very effectively. If water can be evaporated, odor has a good chance to come off with the moisture. If you have an extra set of rolls, moisten the paper in between and send it over the second set. That should have a considerable deodorizing effect.

Question: How does one mask or disguise the odor of phenol or phenolic derivatives?

Mr. Crocker: The best thing is don't fool with it. If you've got a phenolic compound, wash it, air it out, get rid of it, and don't try to cover it up because it's one of those things that won't stay dead. And what's more, strangely enough, I'm going to speak a little bit about the use of pentachlorophenol as a fungicide. You can use small amounts of pentachlorophenol which hasn't too much of an odor of its own in a paper mill to prevent slime. When that is done, the man that runs the machine is usually told to use, say so many pounds during the day. We'll say there are three or four runs, he is supposed to divide his supply with the number of times the product goes through the mill, but very many workmen who don't use their heads put the whole business in with the first batch through in the morning. That comes through loaded, and after that the paper comes untreated. That first lot of paper is sure to cause trouble. But if the preservative were added at various times during the day, everything would be all right. When less than enough pentachlorophenol is present, certain fungi acting on it can reduce that material to lower chlorine derivatives like trichlorophenol, which smell very offensive, so that the preservative can be the original source of some very objectionable odors.

Question: Must your workers refrain from drinking and smoking on working days?

Mr. Crocker: "Your workers" means Flavor Laboratory. Actually we try to live as normally and naturally as possible. So far as cigarette smoking is concerned, we pay no attention to it. We do work for one of the cigarette companies, we have a cigarette panel operating every day and on that cigarette panel there are about equal numbers of smokers and nonsmokers. I must say this—that working on that panel has never made a smoker out of a nonsmoker or a nonsmoker out of a smoker. You keep your religion. You start with it and you stay with it. It's only a day's work so far as the tasting is concerned. The best we have been able to find out is that smoking cigarettes, with proper attention to washing your hands and cleaning your breath before you start work, doesn't reduce your sensitivity markedly.

Question: How do you measure factors included in Profiles?

Mr. Crocker: By psychometric measurement based on concepts in the mind. There are different degrees, such as one degree—slightly strong, two degrees—moderately strong, three degrees—strong, and four—powerful. We may split down to half units and work with the panel members over and over again until they learn the degrees of intensity and all speak the same language. There are no intensity standards that can be used for most of the work. Once in a while we'll have a one standard, a two standard, and a three standard, for certain particular things, both in taste and odor. But by and large it's entirely mental. Incidentally, working with odors and tastes you do well to tell a difference in concentration of 15%. To be sure, with sugars and other sweet things, a difference in 10% in intensity can sometimes be detected, but about 15% of difference is needed before you can count on anything. You might say it is "estimating" in the case of internal measurements, where you are probably off 20 or 25%, but that's good enough for the purpose. Incidentally, what's the function of a panel? Why do you have a panel? Why do you have more than one person? For very many reasons. One person may have prejudices. Prejudices tend to wipe out with the larger group. Repeated observations tend to be more accurate than single ones according to the square root of the number of observations. In other words, with four times the number of observations you've about doubled the accuracy. Nine times, you've about tripled it. We find that cost goes up arithmetically, but accuracy only as the square root of the number, so that by and large you want to keep your panel size as small as is feasible, and usually that works out to four or five except for something very particular, very precise, and then nine or ten.

Question: What could be the most common cause of musty odor in absorbent papers?

Mr. Crocker: That's hard to say. Often the stock they're made from contains musty materials. For instance, if you're

The DRAPER Felt
DRAPER BROTHERS COMPANY
CANTON, MASS.

working with secondhand newspapers and telephone books, they are almost invariably musty. And mustiness is a very hard thing to get rid of. With new stock I don't know where musty odor comes from. Mustiness is most always due to higher alcohols, at least higher alcohols are characteristic of the musty type of odor. Of course, any mold present in the process is productive of musty odors.

Question: Can you get the odor and taste of food without swallowing it, or do you just get the taste?

Mr. Crocker: If you sniff it, you've got the odor. If you taste or put it on your tongue, you've got the taste. So the answer is you don't need to swallow it. As a matter of fact, in tea tasting the expert tea taster may have to taste several hundred samples a day and if he takes even an ounce to the sample, that would be quite a few gallons of tea. So what he generally does is to suck it up against the roof of his mouth with a "slorp" and then spew it out. He is able to do that over and over again all day long. If you work with fatty foods and things like that, you don't want to swallow too much, but ordinarily you can safely swallow the little bit needed and get away with it.

Question: Does the use of a material such as Dowicide overcome the odor condition you spoke about in a casein-coated sheet?

Mr. Crocker: The answer is that you can, by the use of antiseptic, keep casein from going bad. But on the other hand, hygiene is a pretty good practice anyway and doesn't cost anything. It can't possibly backfire on you later.

Question: Aren't mercaptans responsible for the objectional odor associated with kraft paper?

Mr. Crocker: They can be, because there is plenty of mercaptan produced. Paper is rolled up in such tight bundles that it would be very difficult for bundles of paper to pick up any odors from the air no matter how bad the air is. It would tend to pick it up perhaps on the outside layers, but never get into the interior. If the paper smells badly inside, it's got to be odor that wasn't removed rather than odor that was picked up.

Question: Do people smelling the same thing get the same odor and if not, why?

Mr. Crocker: So far as we know, all get about the same odor—but there is some question on that. On testing a great many people, they usually use the same words for describing the same odor and probably get the same sensations. We're all pretty much alike. Our senses have about the same degree of delicacy. In our Flavor Laboratory we used to go to great effort to measure the delicacy of smelling of one person after another who wanted to work on odor, but we found out gradually that almost anybody who is anxious to do the work is automatically all right. Interest is far more important than sensory delicacy.

Question: Would vanillin-treated board ever be objectionable if the odorant was absorbed by a food product?

Mr. Crocker: Vanillin is one of the least objectionable of odorous materials that can be used with a food, but there are plenty of opportunities for a vanillin odor to be objectionable. By the way, I want to bring up this point, what is a stink? A good many people have ideas that a stink is a horrible odor or something like that. But after thinking if over a good many years, I've come up with the answer that a stink is merely an odor out of place. It's the same kind of category as "a weed is a plant out of place." For instance, a petunia plant is a weed when it grows in a potato patch and we pull it out and throw it away, just as we do a potato plant growing in a petunia patch. Suppose a man got a little bit of perfume on his lapel or perhaps all over his coat during a working day. It wouldn't matter how nice the odor; it would be a stink when he got home.

Question: When steam is used to increase an odor, is the resultant odor a true one?

Mr. Crocker: Yes, it is true, but in a particular way. At first the steam removes the lower boiling things, then the medium boiling, and then the higher boiling, and when you smell it in the ensemble before the steam is there, you may get all of those notes together. The steam will tend to analyze it for you, but doesn't do anything to the odor chemically to injure or change it other than to "fan out" its constituents.

Question: Can you explain fluctuation in the ability to smell from day to day? We have an example here—a pipe smoker sometimes senses a flavorful aroma, while other times senses practically none.

Mr. Crocker: The way I feel about it, of course this is only feelings and you can't hold me for those, is that if a person has a rather dull sense of smell it takes a pipe or a rather strong cigar to give him any satisfaction at all. Some days his senses may be more acute than others.

Question: In the case of cigarette smokers, which is more prominent, seeing the smoke or tasting the tobacco?

Mr. Crocker: Nobody enjoys smoking in the dark.

Question: Is there any instrument which can be used in detecting or measuring intensity of odors?

Mr Crocker: There isn't any instrument that can detect any odor. There is a so-called electric sniffer that is able to detect chlorine and other halogen derivatives. That electric sniffer detects halogens but it does not smell things. It detects non-odoriferous halides just as easily as it does powerfully odoriferous compounds like chloroform. Only noses, and in practice, trained ones, can smell usefully.

Question: Will food products absorb all components of a masked odor to the same degree so that the odor again given off is the same original balanced masked odor?

Mr. Crocker: That's quite a complex question. If you mask the odor of paper, the probability is that it will cause less objection to the people using the food that's put in it than as if there were no masking used. But the masking agent as well as the odor has to get into the food in order for it to work on the food as well as it did on the paper. If you mask an odor in the paper, you tend to mask it in the food. I don't recommend masking odors. The best thing to do is to have no odor, or have as low an odor as you can in food containers.

Question: Does odor penetrate beyond the surface, as in egg shells and apple skins, etc.?

Mr. Crocker: Yes, odors penetrate apples. Apples are living things, they are breathing, they are taking in oxygen, and they are giving off carbon dioxide, at least in the dark. Sometimes in the light they reverse that process. But they are a living organism and all living things suck in these odors from the air so that there is penetration there. Egg shells are sufficiently permeable that strawboard character gets in through them. In many instances, eggs are kept in such high humidity that there is an incipient film of moisture over the surface so there can also be taste transmission to some extent.

Question: What are the peculiar odor characteristics of phenols and their derivatives?

Mr. Crocker: Phenols are pungent for one thing, and sweet. I think it is the sting of phenols and the tendency of phenols to put your nose to sleep that bothers people. Speaking of phenols, oil of cloves is a phenol. That will put your tongue or your tooth to sleep. But I don't think this person is interested in pure unchlorinated phenols. The higher chlorinated compounds may have much less odor than the monochlorinated or dichlorinated forms.

Question: Are not the lower chlorinated phenols with higher vapor pressure more apt to be driven off in drying papers?

Mr. Crocker: The answer is yes. If the vapor pressure is high enough you might be able to drive them all off. But on the other hand, one of the meanest of the chlorinated phenols is the monochloride. The cresol compounds are very bad too, and if you have cresol chlorinated it can be very bad.

Moisture in Paper and Paperboard*

Proposed Revision of TAPPI Official Standard T 412 m-42

(THIS STANDARD IS UNDER THE JURISDICTION OF THE CHEMICAL METHODS COMMITTEE)

This method applies to all paper, paperboard, and paper products except those containing significant quantities of materials other than water which are volatile at 105±3°C.

APPARATUS

1. *Weighing Container.* Either a wide-mouth, glass-stoppered weighing bottle approximately 65 mm. ($2^1/_2$ in.) in height and 45 mm. ($1^3/_4$ in.) in diameter, or an airtight metal container, or any other suitable airtight container, depending on the size of the specimen required. The container must be large enough to accommodate the specimens without their being tightly packed.

2. *Thermometer.* Accurate to within 1°C., including the range of 100 to 110°C.

3. *Drying Oven.* A constant-temperature oven, equipped with means of insuring adequate temperature control and air circulation.

Note: There is danger of local overheating if the samples are exposed to the direct rays of unshielded heating elements.

4. *Chemical Balance.* Sensitive to 1 mg. for weighing specimens of 2 grams and less, and sensitive to 0.05% of the original weight of the specimen for larger specimens.

5. *Desiccator.* Anhydrous alumina (indicating grade) is the most suitable desiccant. Calcium chloride and calcium sulphate are unsatisfactory.

TEST SPECIMEN

When the amount of moisture is determined for the purpose of calculating the results of a chemical analysis of paper on a moisture-free basis, the test specimens shall weigh not less than 1 gram and preferably not less than 2 grams each, and, when weighed, shall be in moisture equilibrium with the specimens being chemically analyzed. When moisture is determined for the purpose of calculating the amount of moisture in a shipment of paper, the test specimens shall weigh not less than 50 grams each, and they shall be obtained in accordance with TAPPI Standard T 400 m.

When the amount of moisture is determined on paperboard or containers which are to be tested for other physical properties, test specimens shall weigh approximately 50 grams and shall be taken so as to be representative of the material being tested. In the case of containers, the samples shall be cut from unsealed sections and preferably from unprinted sections of the container.

PROCEDURE

In sampling a shipment for moisture determination extreme care must be taken to avoid change in moisture content during sampling. Handle large specimens with clean, dry, rubber gloves. Transfer the specimens to the weighed container as soon as they are withdrawn and close the container immediately. If a delay of over a few seconds in transferring the specimen to the container is unavoidable, keep the specimen covered on both sides with several adjacent layers of the paper from which it was withdrawn, until ready to place it in the container. Unless the specimen is later to be spread out in the oven, avoid filling the container tightly. After the specimen has been placed in a weighed container, weigh it in the closed container to obtain the wet weight of the test specimen.

Unless the container has a removable basket, remove large specimens from the container in which they were weighed, spread them in a basket or tray which will permit free circulation of air around them, and place them, together with the original containers, in the oven. Heat for about 2 hr. at 105±3°C., replace the specimens in the original container, and close it, doing this, if possible, without removing the specimens from the oven. Let the closed container and contents cool at room temperature, and weigh.

Place small specimens in the drying oven, without removing them from the weighing bottle, remove the stopper of the bottle, heat for about 1 hr. at 105±3°C., close the bottle in the oven, cool to room temperature in a desiccator, and weigh. Loosen the stopper momentarily just before weighing to adjust any change in air pressure.

Repeat the periodic drying and weighing of the specimen until the difference in weight between two successive weighings is not more than 0.1% of the weight of the specimen.

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* This standard incorporates the findings of the 1951 study by the Am. Chem. Soc. Committee and is in essential agreement with the ASTM procedure D 644–44.

This revision has been approved by the Chemical Methods Committee. Criticisms are earnestly requested and should be sent to R. G. Macdonald, Secretary, Technical Association of the Pulp and Paper Industry, 122 E. 42nd St., New York 17, N. Y.

Make all weighings with the cover on the container and weigh to within 0.05% of the total weight of the original specimen.

REPORT

Report the moisture as the percentage loss in original weight of the specimen to the nearest 0.1.

PRECISION

The percentage results of duplicate determinations of moisture made at the same time should agree within 0.2.

ADDITIONAL INFORMATION

The principal change in this revision is an increase in the drying temperature to 105±3°C., whereas 100 to 105°C. was previously specified.

REFERENCES

Committee Report, "Sampling and Testing Paper for Moisture Content," *Paper-Maker and British Paper Trade J.* 119: 32–40 (1950).

Broughton, G., and Hobbs, A. K., "Moisture Determination in Paper by Oven Drying," *Tappi* 35, No. 5: 217 (May, 1952).

Willits, C. O., "Methods for Determination of Moisture. Oven Drying," *Anal. Chem.* 23: 1058 (1951).

EMPLOYMENT SERVICE

Positions Wanted

E184-52. Engineer. Available at once. Graduate Engineer. Over 15 years' experience in pulp, paper and insulating board, mill design, and mill operation. Desires permanent connection of executive assistant or junior executive nature.

E187-52. Plant Engineer. 20 years' experience in groundwood and sulphite specialty mills desires position in northern or midwestern mill. Excellent references.

E188-52. Mill Manager desires change. Capable of taking full charge of operations as Manager or equivalent executive position. Broad practical experience in manufacture of papers, medium quality boards, production of kraft, sulphite and groundwood pulps and paper and paper converting. Engineering graduate.

E189-52. Chemical Engineering graduate. 29. Family. Experience: 1 year naval stores; 6 years' Southeastern pulp and board mill, laboratory, engineering, production supervision. Desires responsible position with pulp and paper company. Prefers southeast location.

E190-52. Young, ambitious executive with excellent qualifications. Technically trained with a broad background of experience. Will consider sales, production, or technical position. Salary required in five figures. Now employed.

E191-52. Engineer. 32. M.S. in Chem. Eng. and B.S in Mech. Eng. 8 years' pulp and paper experience. Desires position in production line or engineering staff, preferably in a small mill.

E192-52. Coating Division manager, 14 years' technical and practical experience. Desires position in management, production or sales. Thorough knowledge of conventional and high speed coating operations.

E193-52. Chemist. B.S. 1950—Married veteran age 29 with two years' experience in control and pilot plant production of sizes, desires employment with a progressive organization in the capacity of technical sales or service. Location immaterial.

E194-52. Chemical Engineer with a B.S. Ch.E. and an M.S. Ch.E. (Pulp and Paper). Age 24. Single. Some experience in pulp and paper mill. One year post graduate study beyond Master's degree. Seeking employment.

E195-52. Graduate Chemist. Over 7 years' technical experience in paperboard manufacturing and converting problems plus supervisory work. Desires a challenging position with a future, preferably in the Middle West. Write for full qualifications and personal data.

Positions Open

P207-52. Sales Engineers. West Coast pump manufacturer has openings in its sales offices for graduate engineers familiar with the pulp and paper industry. A minimum experience of 5 years of pulp and paper service or with equipment firm who specialize in pulp and paper machinery. Give complete background of education, experience, and salary requirement, along with recent photograph.

P230-52. Man with chemical training and 2–3 years' experience in paper mill operations, for technical service by chemical manufacturer. A permanent position with a growing company.

P232-52. Paper Buyer. Man with a paper industry background to take over the buying of all types of paper, paper boxes, cartons, and various other packaging materials for a large rubber manufacturing company located in New York City.

P233-52. Superintendent for Eastern mill manufacturing facial tissue. Must be capable of handling extra wide high-speed Yankee machine. Excellent salary. Correspondence confidential. Our personnel acquainted with this advertisement.

P234-52. Research Chemist or Chemical Engineer for Southern Sulphate pulp and paper mill expanding research activities to study semichemical pulping of hardwoods.

P235-52. Research Chemist for West Coast plant engaged in manufacturing packaging papers. Man should be well grounded in the fundamentals of paper manufacture or paper converting and have a fair knowledge of printing or printing inks. Excellent laboratory facilities.

P236-52. Paper chemist or engineer for research and quality control work with manufacturer in the Midwest region. Recent graduate, with laboratory or mill experience. Experience in converting of paperboard also desirable. Reply giving personal history, education, experience, and salary expected.

P237-52. Wanted. 1 Plant Manager, 1 General Superintendent, 1 Chief Engineer, 1 Plant Chemist, and 1 Industrial Engineer for integrated asphalt roofing mill, having power plant, felt mill, roofing mill, and related units. Each opening offers excellent career opportunity in well established Middle West company. Age to 45. Like industry experience desirable, but not essential. Give full details in first letter, stating experience, background, and salary desired.

P238-52. Chemist wanted by mill manufacturing sulphite and rag writing papers.

P239-52. General Operating Manager. New company in New Zealand to manufacture 60,000 tons newsprint, kraft pulp and sawn timber. Needed now to take part in design and layout of mills, select machinery, employ and supervise personnel. Seven year contract.

CHEMIST

Product Development—Chemist engineer, minimum three years' pulp and paper experience. Wanted for research organization of prominent manufacturer. Vicinity Metropolitan New York. Please send full particulars to *Tappi* P 240-52, 122 East 42nd Street, New York 17, N. Y.

SALES ENGINEERING ASSISTANT TO DIVISION HEAD

We need man who is a graduate engineer and preferably now connected with maintenance department of large pulp and paper mill. Unusual opportunity. Send detailed application, with photograph to *Tappi* P 231-52, 122 East 42nd Street, New York 17, N. Y.

Seventh Engineering Conference of the Technical Association of the Pulp and Paper Industry

Morrison Hotel, Chicago, Ill.

Oct. 13–16, 1952

TAPPI Fibrary

Addendum I

This catalog is the second to be published for the TAPPI Fibrary, for which collection efforts were initiated in October, 1949. (See *Tappi* 34, No. 2: 26 A, Feb., 1951, for first list.) There are still many fibers which are needed. It is hoped that contributions of missing species will be forthcoming from TAPPI members so this fiber collection may continue to enlarge and increase in value. Further addenda to this index will be published as occasion requires.

A representative specimen of each fiber may be obtained from the Fibrary, The Institute of Paper Chemistry, Appleton, Wis. Each sample has a number which may be used in ordering. A service charge of 25 cents ($0.25) per sample has been established to help defray the cost of handling, packing, and postage. Remittance of the necessary fee at the time of ordering will help to keep these costs as low as possible.

The custodians of the Fibrary have checked, to the best of their ability, all fibers submitted, as to species and process. Please write us if any error is detected.

The amount of pulping data given by the donor varies considerably in different samples. Because of space limitations many of the details which have been sent with the sample will not be published but will be filed with the sample for reference purposes. Naturally, it is desirable to have complete details, if available.

No acknowledgment has been made in the catalog to the donors for the various samples. In many instances several companies or individuals offered the same fibers and while duplication is inevitable, ever effort was made to avoid it to conserve space without decreasing the effectiveness of the fiber collection. Unquestionably, the gratitude of the industry is due these anonymous donors.

Fibrary, Addendum I

No.	*Species*	*Location grown*	*Process*	*Degree of cooking*	*Bleaching*	*Remarks*
195	Acacia, bullhorn (*Acacia auricularis*)	Florida	Kraft	Medium	None	.....
196	Alder, red (*Alnus rubra*)	British Columbia	Sulphite	Medium	None	Laboratory screened
197	Alder, red (*Alnus rubra*)	Oregon	Neutral sulphite semichemical	Intermediate yield	None	.....
198	Ash, mountain (*Eucalyptus regnans*)	Australia	Kraft	Medium	None	.....
199	Ash, mountain (*Eucalyptus regnans*)	Australia	Kraft	Medium	None	Sapwood
200	Ash, mountain (*Eucalyptus regnans*)	Australia	Kraft	Medium	None	Heartwood
201	Aspen, European (*Populus tremula*)	Sweden	Sulphite	.....	Full	.....
202	Aspen (*Populus tremuloides*)	New York	Chemigroundwood	.....	None	.....
203	Aspen (*Populus tremuloides*)	Michigan	Kraft semichemical	High yield	None	.....
204	Aspen (*Populus tremuloides*)	Michigan	Kraft (Asplund)	.....	None	.....
205	Bamboo (*Bambusa arundinacea*)	Australia	Kraft	Hard	None	.....
206	Bamboo (Daba or Kanta) (*Bambusa arundinacea*)	India	Sulphite	Soft	None	Magnesia base
207	Bamboo (Daba or Kanta) (*Bambusa arundinacea*)	India	Sulphite	Soft	Semi	Magnesia base
208	Bamboo (Daba or Kanta) (*Bambusa arundinacea*)	India	Sulphite	Soft	Full	Magnesia base
209	Bamboo (Balki or Baluki) (*Bambusa balcooa*)	India	Sulphite	Soft	None	Magnesia base
210	Bamboo (Balki or Baluki) (*Bambusa balcooa*)	India	Sulphite	Soft	Semi	Magnesia base
211	Bamboo (Balki or Baluki) (*Bambusa balcooa*)	India	Sulphite	Soft	Full	Magnesia base
212	Bamboo (Salia) (*Dendrocalamus strictus*)	India	Sulphite	Soft	None	Magnesia base
213	Bamboo (Salia) (*Dendrocalamus strictus*)	India	Sulphite	Soft	Semi	Magnesia base
214	Bamboo (Salia) (*Dendrocalamus strictus*)	India	Sulphite	Soft	Full	Magnesia base
215	Bamboo (Muli or Mitenga) (*Melocanna bambusoides*)	India	Sulphite	Soft	None	Magnesia base
216	Bamboo (Muli or Mitenga) (*Melocanna bambusoides*)	India	Sulphite	Soft	Semi	Magnesia base
217	Bamboo (Muli or Mitenga) (*Melocanna bambusoides*)	India	Sulphite	Soft	Full	Magnesia base
218	Barley straw (*Hordeum vulgare*)	Holland	Lime semichemical	.....	None	.....
219	Birch, paper (*Betula papyrifera*)	Wisconsin	Sulphite	Soft	None	Mitscherlich
220	Birch, paper (*Betula papyrifera*)	Wisconsin	Sulphite	Medium	Full	Mitscherlich
221	Birch, paper (*Betula papyrifera*)	Wisconsin	Kraft	Soft	None	.....
222	Birch, paper (*Betula papyrifera*)	Wisconsin	Kraft	Soft	Full	Three-stage bleach
223	Birch, paper (*Betula papyrifera*)	Wisconsin	Neutral sulphite semichemical	60 % yield	None	.....
224	Birch, paper (*Betula papyrifera*)	Wisconsin	Neutral sulphite semichemical	73% yield	None	.....
225	Birch, paper (*Betula papyrifera*)	Wisconsin	Neutral sulphite semichemical	73% yield	Full	Three-stage bleach
226	Birch, Swedish	Sweden	Sulphite	.....	Full	.....
227	Birch, yellow (*Betula lutea*)	New York	Chemigroundwood	.....	None	.....
228	Black-mangrove (*Avicennia nitida*)	Florida	Kraft	Soft	None	.....
229	Blady grass (*Imperata cylindrica*)	New Guinea	Soda	Medium	None	.....
230	Butterbough (*Exothea paniculata*)	Florida	Kraft	Soft	None	.....

No.	Species	Location grown	Process	Degree of cooking	Bleaching	Remarks
231	Buttonbush, common (*Cephalanthus occidentalis*)	Florida	Kraft	Soft	None	.....
232	Button-mangrove (*Conocarpus erecta*)	Florida	Kraft	Hard	None	.....
233	Chinkapin, Ashe (*Castanea ashei*)	North Carolina	Kraft	Soft	None	.....
234	*Coelorachis rottboellioides*	New Guinea	Soda	Medium	None	Grass
235	Cottonwood, northern black (*Populus trichocarpa* var. *hastata*)	British Columbia	Sulphite	Medium	None	Laboratory screened
236	Cypress pine, black (*Callitris calcarata*)	Australia	Kraft	Medium	None	.....
237	Cyrilla, American (*Cyrilla racemiflora*)	Florida	Kraft	Soft	None	.....
238	Damanu (*Calophyllum* sp.)	Fiji	Kraft	Medium	None	.....
239	Darling-plum (*Reynosia septentrionalis*)	Florida	Kraft	Medium	None	.....
240	Davota (*Calophyllum* sp.)	Fiji	Kraft	Medium	None	.....
241	Dove-plum (*Coccolobis laurifolia*)	Florida	Kraft	Soft	None	.....
242	Eugenia, redberry (*Eugenia confusa*)	Florida	Kraft	Soft	None	.....
243	Eugenia, spiceberry (*Eugenia rhombea*)	Florida	Kraft	Soft	None	.....
244	Eugenia, white-stopper (*Eugenia axillaris*)	Florida	Kraft	Soft	None	.....
245	False-mangrove (*Laguncularia racemosa*)	Florida	Kraft	Soft	None	.....
246	False-mastic (*Sideroxylon foetidissimum*)	Florida	Kraft	Soft	None	.....
247	Farkleberry tree (*Vaccinium arboreum*)	North Carolina	Kraft	Soft	None	.....
248	Fir, grand (*Abies grandis*)	British Columbia	Sulphite	Medium	None	Laboratory screened
249	Fir, white (*Abies concolor*)	California	Kraft	Soft	None	.....
250	Fishfuddle tree, Florida (*Ichthyomethia communis*)	Florida	Kraft	Medium	None	.....
251	Flax (*Linum usitatissimum*)	Holland	Soda	Soft	Full	Linen; beaten
252	Flax (*Linum usitatissimum*)	Holland	Soda	.....	None	Straw from oil plants
253	Flax (*Linum usitatissimum*)	Minnesota	Soda	.....	Full	Straw from oil plants
254	Gum, mountain gray (*Eucalyptus goniocalyx*)	Australia	Kraft	Medium	None	.....
255	Gum, scribbly (*Eucalyptus micrantha*)	Australia	Kraft	Medium	None	.....
256	Gum, sugar (*Eucalyptus cladocalyx*)	Australia	Kraft	Medium	None	.....
257	Gumbo-limbo (*Elaphrium simaruba*)	Florida	Kraft	Medium	None	.....
258	Hemp rope (*Cannabis sativa*)	.....	Soda	None	..	.....
259	Hemp rope (*Cannabis sativa*)	Spain	Soda	Soft	Full	Fishing nets
260	Ilang-ilang (*Canangium odoratum*)	Philippine Islands	Kraft	Soft	None	.....
261	Ilang-ilang (*Canangium odoratum*)	Philippine Islands	Kraft	Soft	Full	Three-stage bleach
262	*Imperata exaltata*	New Guinea	Soda	Medium	None	.....
263	Kauri, Fiji (*Agathis vitiensis*)	Fiji	Kraft	Medium	None	.....
264	Kauri, South Queensland (*Agathis robusta*)	Australia	Kraft	Medium	None	.....
265	Kauvula (*Endospermum macrophyllum*)	Fiji	Kraft	Medium	None	.....
266	Lancewood (*Nectandra coriacea*)	Florida	Kraft	Soft	None	.....
267	Larch, western (*Larix occidentalis*)	Idaho	Kraft	Soft	None	.....
268	Leadwood (*Krugiodendron ferreum*)	Florida	Kraft	Soft	None	.....
269	Lignumvitae (*Guaiacum sanctum*)	Florida	Kraft	Soft	None	.....
270	Loblolly-bay (*Gordonia lasianthus*)	Florida	Kraft	Soft	None	.....
271	Lysiloma, Bahama (*Lysiloma bahamensis*)	Florida	Kraft	Medium	None	.....
272	Mahogany, West Indies (*Swietenia mahagoni*)	Florida	Kraft	Soft	None	.....
273	Mallet (*Eucalyptus occidentalis*)	Australia	Kraft	Medium	None	.....
274	Mangrove, red (*Rhizophora mangle*)	Florida	Kraft	Soft	None	.....
275	Manila fiber (*Musa textilis*)	.....	Neutral sulphite	.....	..	Reclaimed rope; cooked in U. S.
276	Maple, Carolina red (*Acer rubrum* var. *tridens*)	Florida	Kraft	Soft	None	.....
277	Maple, sugar (*Acer saccharum*)	New England	Kraft	Soft	None	.....
278	Maple, sugar (*Acer saccharum*)	New England	Kraft	Soft	Full	.....
279	Maple, sugar (*Acer saccharum*)	New England	Neutral sulphite semichemical	70% yield	None	.....
280	Maple, sugar (*Acer saccharum*)	New England	Neutral sulphite semichemical	70% yield	Full	Three-stage bleach
281	Milkbark (*Drypetes diversifolia*)	Florida	Kraft	Hard	None	.....
282	New Zealand flax (*Phormium tenax*)	Australia	Soda	Hard	None	.....
283	Oak, bluejack (*Quercus cinerea*)	Florida	Kraft	Soft	None	.....
284	Oak, laurel (*Quercus laurifolia*)	Florida	Kraft	Soft	None	.....
285	Oak, live (*Quercus virginiana*)	Florida	Kraft	Soft	None	.....
286	Oak, northern red (*Quercus borealis*)	New England	Sulphite semichemical	58% yield	None	Ammonia base; unbarked
287	Oak, overcup (*Quercus lyrata*)	Florida	Kraft	Soft	None	.....
288	Oak, overcup (*Quercus lyrata*)	Arkansas	Kraft	Soft	Full	.....
289	Oak, sand live (*Quercus virginiana* var. *geminata*)	Florida	Kraft	Soft	None	.....
290	Oak, silky (*Grevillea robusta*)	Australia	Kraft	Medium	None	.....
291	Oak, small post (*Quercus margaretta*)	North Carolina	Kraft	Soft	None	.....
292	Oak, southern red (*Quercus rubra*)	North Carolina	Kraft	Soft	None	.....
293	Oak, swamp chestnut (*Quercus primus*)	Florida	Kraft	Soft	None	.....
294	Oak, turkey (*Quercus laevis*)	Florida	Kraft	Soft	None	.....
295	Oak, water (*Quercus nigra*)	North Carolina	Kraft	Soft	None	.....
296	Oak, white (*Quercus alba*)	North Carolina	Kraft	Soft	None	.....
297	Oat straw (*Avena sativa*)	Holland	Lime semichemical	.....	None	.....
298	Oysterwood, shiny (*Gymnanthes lucida*)	Florida	Kraft	Hard	None	.....
299	*Phragmites communis* reed	Holland	Soda	.....	None	.....
300	Pine, bishop (*Pinus muricata*)	Australia	Kraft	Medium	None	12-Yr.-old trees
301	Pine, bunya (*Araucaria bidwilli*)	Australia	Kraft	Medium	None	.....
302	Pine, hoop (*Araucaria cunninghami*)	Australia	Kraft	Medium	None	.....

No.	Species	Location grown	Process	Degree of cooking	Bleaching	Remarks
303	Pine, jack (*Pinus banksiana*)	Wisconsin	Neutral sulphite semichemical	High yield	None	.....
304	Pine, loblolly (*Pinus taeda*)	Mississippi	Asplund	.....	None	.....
305	Pine, loblolly (*Pinus taeda*)	Mississippi	Groundwood	.....	None	.....
306	Pine, longleaf (*Pinus palustris*)	Florida	Kraft	Soft	None	.....
307	Pine, Parana (*Araucaria brasiliensis*)	Brazil	Kraft	Medium	None	8-Yr.-old trees
308	Pine, Parana (*Araucaria brasiliensis*)	Brazil	Kraft	Medium	None	Sapwood
309	Pine, Parana (*Araucaria brasiliensis*)	Brazil	Kraft	Medium	None	Heartwood
310	Pine, Parana (*Araucaria brasiliensis*)	Brazil	Neutral sulphite semichemical	78% yield	None	8-Yr.-old trees
311	Pine, Parana (*Araucaria brasiliensis*)	Brazil	Neutral sulphite semichemical	77% yield	None	Sapwood
312	Pine, Parana (*Araucaria brasiliensis*)	Brazil	Neutral sulphite semichemical	75% yield	None	Heartwood
313	Pine, Parana (*Araucaria brasiliensis*)	Brazil	Sulphite	Soft	None	8-Yr.-old trees
314	Pine, Parana (*Araucaria brasiliensis*)	Brazil	Sulphite	Medium	None	Sapwood
315	Pine, Parana (*Araucaria brasiliensis*)	Brazil	Sulphite	Medium	None	Heartwood
316	Pine, slash (*Pinus caribaea*)	Georgia	Kraft semichemical	Intermediate yield	None	.....
317	Pine, slash (*Pinus caribaea*)	Georgia	Kraft semichemical	Intermediate yield	None	Unbarked
318	Pine, slash (*Pinus caribaea*)	Georgia	Sulphite semi-chemical	Intermediate yield	None	Ammonia base
319	Pine, slash (*Pinus caribaea*)	Georgia	Kraft (Asplund)	Low yield	None	.....
320	Pine, slash (*Pinus caribaea*)	Georgia	Neutral sulphite (Asplund)	High yield	None	.....
321	Pine, slash (*Pinus caribaea*)	Georgia	Neutral sulphite semichemical	High yield	None	Unbarked
322	Pine, western white (*Pinus monticola*)	Idaho	Kraft	Soft	None	.....
323	Pita or Century plant (*Agave americana*)	Spain	Soda	Soft	Full	.....
324	Pondapple (*Annona glabra*)	Florida	Kraft	Soft	None	.....
325	Poplar (*Populus* sp.)	United States	Sulphite semi-chemical	65% yield	None	Ammonia base
326	Ramie (*Boehmeria nivea* var. *tenacissima*)	.....	Soda	.....	None	Cooked in Holland; source unknown
327	Red-cedar, western (*Thuja plicata*)	Idaho	Kraft	Soft	None	.....
328	Rice straw (*Oryza sativa*)	Java	De Vains	.....	Full	.....
329	Rye straw (*Secale cereale*)	Holland	Lime semichemical	.....	None	.....
330	Sabai grass (*Ischaemum angustifolium*)	India	Sulphite	Soft	None	Magnesia base
331	Sal (*Shorea robusta*)	India	Soda	Soft	Full	.....
332	Sapota, American (*Achras zapota*)	Florida	Kraft	Soft	None	.....
333	Sassafras (*Sassafras veriifolium*)	North Carolina	Kraft	Soft	None	.....
334	Savannah grass (*Saccharum spontaneum*)	New Guinea	Soda	Medium	None	.....
335	Seagrape, common (*Coccolobis uwifera*)	Florida	Kraft	Soft	None	.....
336	Silverbell, Carolina (*Halesia carolina*)	North Carolina	Kraft	Soft	None	.....
337	Spruce, Sitka (*Picea sitchensis*)	British Columbia	Sulphite	Medium	None	Laboratory screened
338	Sugar cane bagasse (*Saccharum officinarum*)	.....	Soda	.....	None	Cooked in Holland; source unknown
339	Sweetgum (*Liquidambar styraciflua*)	Georgia	Kraft semichemical	Low yield	None	Unbarked
340	Sweetgum (*Liquidambar styraciflua*)	Georgia	Kraft semichemical	Intermediate yield	None	Unbarked
341	Sweetgum (*Liquidambar styraciflua*)	Georgia	Kraft semichemical	High yield	None	Unbarked
342	Sweetgum (*Liquidambar styraciflua*)	Georgia	Kraft (Asplund)	Low yield	None	Unbarked
343	Sweetgum (*Liquidambar styraciflua*)	Georgia	Neutral sulphite (Asplund)	.....	None	Unbarked
344	Sweetgum (*Liquidambar styraciflua*)	Georgia	Neutral sulphite semichemical	Low yield	None	Unbarked
345	Trema, Florida (*Trema mollis*)	Florida	Kraft	Soft	None	.....
346	Tupelo, black (*Nyssa sylvatica*)	Georgia	Kraft	.....	None	.....
347	Tupelo, black (*Nyssa sylvatica*)	Georgia	Kraft	.....	Full	.....
348	Tupelo, water (*Nyssa aquatica*)	Georgia	Kraft	Soft	None	.....
349	Wattle, green (*Acacia irrorata*)	Australia	Kraft	Medium	None	.....
350	Wattle, hickory tanning (*Acacia falciformis*)	Australia	Kraft	Medium	None	.....
351	Wattle, silver (*Acacia dealbata*)	Australia	Kraft	Medium	None	Sapwood
352	Wattle, silver (*Acacia dealbata*)	Australia	Kraft	Medium	None	Heartwood
353	Wattle, silver (*Acacia dealbata*)	Australia	Kraft	Medium	None	.....
354	Wax-myrtle, Southern (*Myrica cerifera*)	Florida	Kraft	Medium	None	.....
355	Wheat straw (*Triticum vulgare*)	Holland	Lime semichemical	.....	None	.....
356	Wheat straw (*Triticum vulgare*)	Holland	Neutral sulphite	Soft	None	.....
357	Wheat straw and oat straw	Holland	Neutral sulphite	Soft	None	50-50 Mixture
358	Yaupon (*Ilex vomitoria*)	Florida	Kraft	Soft	None	.....
359	Yellow-poplar (*Liriodendron tulipifera*)	Virginia	Neutral sulphite semichemical	73% yield	None	.....

Instrumentation Studies. LXXIV. Determination of the Bonding Strength of Paper

IV. Progress Report on the Development of a New Method and New Instrument

W. A. WINK, THOMAS J. CLINTON, RICHARD W. THICKENS and J. A. VAN DEN AKKER

This report describes the new IPC bonding strength tester, presents data on instrumental and procedural variables, and discusses a limited attempt to correlate the instrumental evaluation of commercial coated papers with their pressroom performance. The new instrument, an outgrowth of an earlier apparatus reported to the American Paper and Pulp Association in 1942, is a rotary device, so designed that end-point data may be obtained in a single run. Upon removal from the instrument, the specimen strip is inspected for end points and the corresponding VVP (viscosity-velocity product) values are read at once from a scale laid alongside the strip. Of the various viscous materials that have been investigated, polyisobutylene (PIB) appears to be the most suitable for the film which generates the disruptive stress on the paper specimen. This material appears to be Newtonian (although viscosity measurements cannot be made at the high rates of shear existing during a run) and is very stable. Various procedural techniques and variables are discussed, including the method for mounting the specimen strip (or strips when only short lengths are available), inspection of end points, the influence of contaminations of the paper (especially fingerprints), the influence of specimen backing, the influence of load on the film-carrying wheel, and the influence of the thickness of the viscous film. At least three end points may be simultaneously employed: (1) the onset of blistering, (2) the onset of slight picking, and (3) the onset of general rupture. Fingerprints inhibit the disruption of the paper surface and, hence, the operator of the equipment handles the paper with canvas gloves. There is only a weak dependence of the VVP on the loading of the film-carrying wheel, and this is suggestive of the possibility that the disruptive stress occurs in a circumferentially very narrow zone in the film at the trailing edge of the load-bearing zone or close to the region of splitting of the viscous film. Within a fairly wide range there is generally a weak dependence of the VVP on the film thickness; in consequence, the error arising in variability of the film thickness is usually very small. The dependence of the VVP on film thickness is not the same for all papers, and it is concluded from this observation that the VVP may not in all cases be regarded as an accurate measure of bonding strength. In the absence of better means for measuring the bonding strength of paper in a direction perpendicular to the sheet, the error cannot be measured. A comparison of the reported pressroom performance, with regard to blistering, picking, and splitting, with the VVP of a series of commercial coated papers shows that the correlation is of about the order that one might expect in view of the lack of control of various important variables in commercial printing operations.

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PART III of this study, which appeared on March 23, 1942, and was subsequently published as Instrumentation Studies LV (*1*), described the development of a new method for evaluating the bonding strength of paper (in a direction perpendicular to the plane of the paper). In addition to describing the early form of the apparatus and presenting techniques, that report set forth the definition of VVP (viscosity-velocity product, which is the measure of bonding strength) and presented data on the VVP which showed that: (1) the VVP for a given paper is constant for films of viscosity covering a large range, (2) there might be an optimum film thickness, at some value less than 0.002 in., and (3) for film thicknesses 0.0004 and 0.0008 in., there is good positive correlation between the observed VVP of coated paper and the casein content. The chief drawback of the early form of the apparatus was that several runs had to be made for the determination of the VVP of a single sample of paper. This was due to the fact that the wheels which carried the viscous films on their flat rims were driven over the paper specimens at essentially constant speed; the speed was changed from run to run and, by observing the absence or onset or degree of rupture produced in the specimens, the operator "bracketed" the critical speed. The idea suggested itself of producing a rotary form of the apparatus in which the specimens would be carried on the flat rims of a pair of steel wheels (rather than on flat beds), and in which the system of two pairs of wheels would accelerate in a known manner from rest to a high rotational speed. Then, if the viscosity of the films on the upper pair of wheels were in the proper range for the paper under test, the specimens would reveal, at the conclusion of a single run, a complete pattern of rupture versus VVP—a pattern displaying all degrees of rupture from slight picking and blistering to complete disruption of the paper. Following World War II, the Mechanical Research Department of the American Newspaper Publishers Assoc. sponsored the design and construction of a rotary apparatus, a brief description of which is presented in the following section.

The purpose of the present report is to present information about the new instrument and to give data, acquired with the new device, concerning instrumental variables and the relationship between the VVP of paper and the resistance of paper to picking in printing operations.

THE NEW IPC SURFACE BONDING STRENGTH TESTER

The rotary form of the bonding strength tester has been described in some detail in a report published by

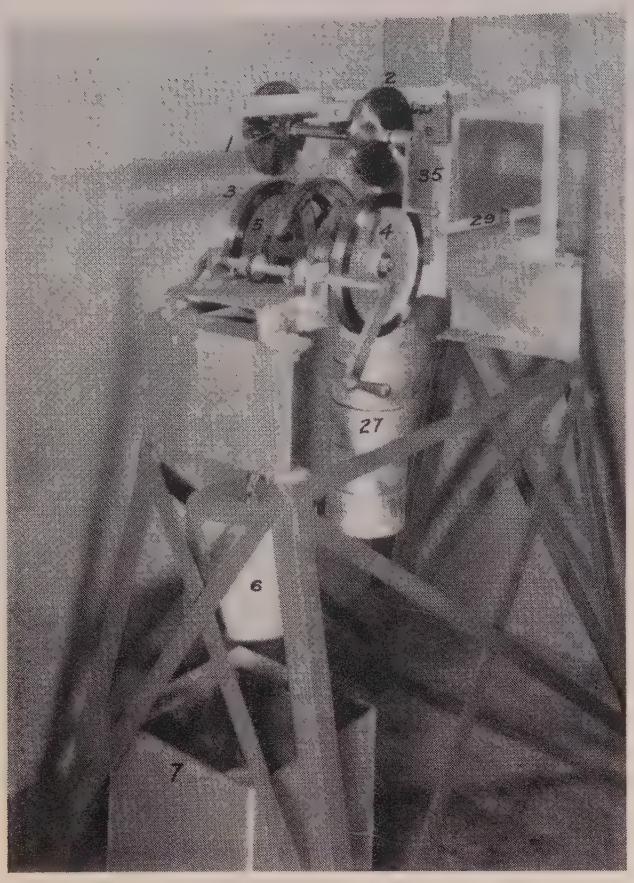

Fig. 1. The new IPC surface bonding strength tester

Shown in cocked condition, with the drive wheel (1) and the film-carrying wheel (2) in the raised position. The specimen strip is carried on wheel (4). The crank (35) is used only for the film-forming operation and is removed before the run is initiated.

the American Newspaper Publishers Assoc. (*2*). General and close-up views of the machine are given in Figs. 1 and 2. As used at the present time, the specimen, in the form of a strip 1 in. wide, is mounted on wheel 4 by means of double-faced, pressure-sensitive paper tape (No. 400, Minnesota Mining and Manufacturing Co.). Wheel 2 carries a film of polyisobutylene of predetermined thickness and of suitable, known viscosity. Wheel 3 is equipped with two layers of common electrician's friction tape, on which wheel 1 rides; the upper wheels (1 and 2) are bolted on a common shaft; wheel 1 serves as a driver, eliminating slippage between the peripheries of wheels 2 and 4.

When the upper wheels are lowered into contact with the lower wheels by means of lever 29 (Fig. 1), the adjustable weight (27) causes wheel 2 to bear upon the specimen with a known loading. The system is set into motion by the falling of a massive weight (6), which transmits motion via a steel cable engaging the drive wheel (5). Wheels 3, 4, and 5 are rigidly mounted on a common shaft, which also carries a gear wheel (11), which is used in the lifting of the driving weight. As a result of the smallness of friction of the system and of the largeness of the driving weight (180 lb.), the observed relationship between the peripheral speed of the specimen and the arc distance (distance along the specimen from the starting position) is reliably uniform; the speed at any point on the specimen is ascertained at once after a run by measuring the distance along the specimen to the point and referring to a chart.*

The falling weight is stopped by a cushion of several layers of sponge rubber in a steel box (7). At the moment the weight is stopped, the wheels have rotated about $^2/_3$ revolution, and a one-way brake (8) becomes engaged, stopping the wheels in the remaining $^1/_3$ revolution.

The driving weight is released by means of the lever (12) (Fig. 2), which engages a heavy pin in the side of the drive wheel (5). The lever (12) is actuated by disengaging the guard (13) from the end of the shaft (14), and the shaft is sharply pushed to the left (as seen in Fig. 2). This operation first disengages the gears (11 and 15) and then causes the collar (16) to move the tripping lever (12). The upper wheels are lifted by means of the lever 29 (Fig. 1). To return the system to readiness for the next run, the gears (11 and 15) are engaged, the guard (13) is returned to engagement with the end of the shaft (14), the pawl of ratchet 18 is engaged, and the crank (17) is turned until the release lever (12) may be reset. The pawl on ratchet 18 is disengaged. The guard (13) and the ratchet (18) serve as safety features; the former prevents the shaft (14) from shifting and permitting the gears (11 and 15) to become disengaged while the weight is being raised, and the latter prevents the crank from whipping around under the action of the weight in the event that the operator's hand should slip.

As in work with the earlier form of the apparatus, the temperature of the film-carrying wheel (2) is measured by means of a sensitive thermocouple (so constructed as to serve as a "surface pyrometer"). The junction of

* A rule has recently been constructed which reads directly in centimeters per second.

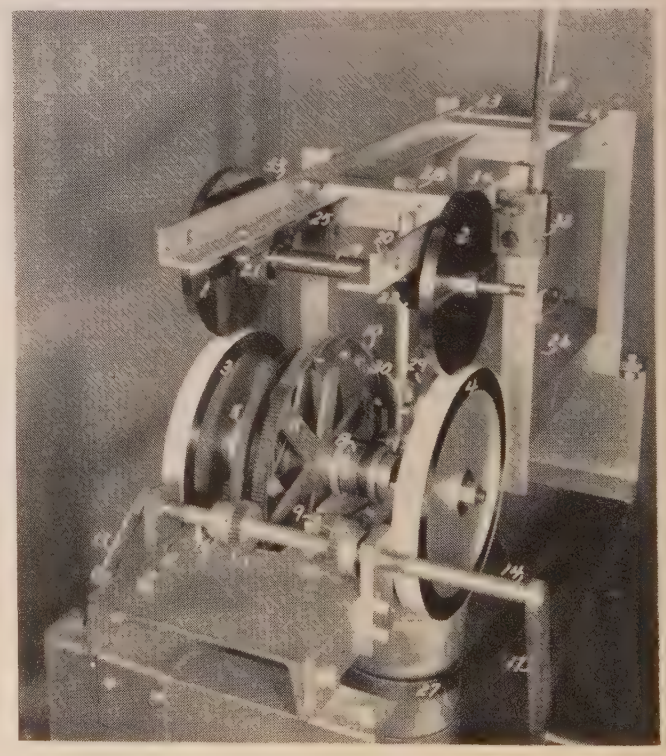

Fig. 2. Close-up view of the new IPC bonding strength tester

Shown in readiness for a run.

the thermocouple is applied to the side of the wheel at points near the rim, and the temperature so obtained is employed to obtain an accurate measure of the viscosity of the film on the rim.

A film of predetermined thickness is formed on wheel 2 by means of a tool similar to that described in Part III of this study (Fig. 5 of reference *1*). This applicator has been improved; in the new design, the doctor blade, when in need of adjustment, is moved to proper position by careful manipulation of three fine-threaded screws. Wear of the four feet of the tool has been greatly reduced by chromium plating. The turning of wheel 2 involved in the forming of the film is quickly effected by means of the small, detachable crank 35.

INSTRUMENTAL AND PROCEDURAL VARIABLES

In nearly all the work with the first bonding strength tester, and in the first phases of our investigations with the new rotary form of the device, the material used for the viscous film on the film-carrying wheel (wheel 2 of Figs. 1 and 2) was blown castor oil. It was observed, however, that certain specimens of blown castor oil seemed to become badly non-Newtonian on aging. In a search for a more suitable material, polyisobutylene (hereafter referred to as PIB) was found to be quite satisfactory; its application in the present work was at different viscosity levels corresponding to various degrees of polymerization (in the various grades of "Vistac," supplied by the Advance Solvents and Chemical Corp., 245 Fifth Ave., New York 16, and "Indopol Polybutene," supplied by the Indoil Chemical Co., 910 S. Michigan Ave., Chicago 80).

The viscosities of the various grades of polyisobutylene are determined by means of the falling ball method. Small steel balls of accurately known diameters are employed; the PIB under test is contained in a vessel whose diameter is about 20 times that of the balls (to eliminate wall effects), and the terminal velocity of a ball is determined by timing the free fall through an accurately known distance (about 15 cm.). A determination is made only after the vessel has attained thermal equilibrium in a constant-temperature bath. Three different temperatures are employed (e.g., 20.37, 23.36, and 25.12°C.) and viscosity-temperature charts are constructed for each of the grades of PIB and for each of the blends of the grades. Actually, the same Beckmann thermometer is employed in the constant-temperature bath and in the thermocouple system employed on the instrument for the measurement of the temperature of the film-carrying wheel, so that the temperature-viscosity charts may be employed with very good accuracy.

The accuracy just referred to is in the obtaining of the viscosity of the film corresponding to the rate of shear existing in the falling ball test; it is not the accuracy in determining the viscosity of the film at a rate of shear of the order of magnitude of that involved in the operation of the bonding strength tester. The latter rate of shear is estimated to be of the order of 50,000 to 200,000 sec.$^{-1}$, whereas the shear rate in the falling ball test is estimated to be thousands of times smaller than this. This would be of no consequence if PIB were strictly Newtonian; however, there is no assurance that PIB is a Newtonian liquid, for there appears to be no accurate means for measuring the viscosity of liquids at very high rates of shear (certain methods would seem to be feasible but, because the viscosity is very high, the appreciable development of heat during the testing would cause substantial error through the strong dependence of viscosity on temperature). Viscosity data have been obtained for various grades of PIB using the reversed Wagner ball-cup method (*3*), in which the ball is forced into the cup rather than pulled from it. The rate of shear involved in this test is considerably greater than that for the falling ball method, being perhaps of the order of the geometric mean of the shear rates for the latter and the value estimated for the bonding strength tester. The range of rate of shear covered in the use of the reversed ball-cup method, for any given grade of PIB, was of the order of 20 to 40-fold. Over this relatively large range, all the tested grades of PIB were found to be Newtonian within experimental error. This evidence indicates the likelihood of, but does not prove, Newtonian behavior of PIB under the conditions of actual testing with the bonding strength tester. Corroborative evidence was found in the comparison of the VVP for a given paper, using "Indopol Butylene H-100" (0.300 kp. at 22.0°C.), with the VVP, for the same paper, using a mixture of the very low viscosity "Indopol Butylene L-100," and the very high viscosity "Vistac No. 4" (the mixture had a viscosity of 0.105 kp. at 22.0°C.). The observed VVP values were essentially the same. If these liquids were not Newtonian, it would be expected that the mixture of PIB of low and high degrees of polymerization would not possess the same rheological behavior as that of the purer compound. It is also notable that the viscosities of the mixture and of the purer compound were different by a factor of 2.86; independence of the VVP of this large variation in viscosity is alone good evidence for Newtonian behavior.

Information on the viscosities of the various compounds and mixtures employed, their temperature dependence, and stability against aging are presented in Table I.

It should be noted that the temperatures for the determinations in January and June were not quite the same, so that the aging effect was determined through the use of the viscosity-temperature charts. In this way it was found that, in a half-year period, one of the

Table I. Dependence of Viscosity of Film Materials on Temperature and Age

PIB	*Viscosity at 25.12°C., kp.*	*Viscosity at 23.36°C., kp.*	*Viscosity at 20.37°C., kp.*
	Jan., 1951		
Indopol H-100	0.222	0.265	0.356
Vistac No. 1	0.738	0.869	1.151
Vistac No. 2	1.670	1.953	2.605
Vistac No. 4	4.991	5.833	7.757
Indopol L-100 and Vistac No. 4	0.0714	...	0.129
Indopol L-100 and Vistac No. 1	0.361	...	0.564
Vistac No. 2 and Vistac No. 4	2.617	...	4.095
	June, 1951		
	Viscosity at 25.13°C., kp.	*Viscosity at 22.52°C., kp.*	*Viscosity at 19.94°C., kp.*
Indopol H-100	0.225	0.289	0.372
Vistac No. 1	0.740	0.943	1.201
Vistac No. 2	1.670	2.135	2.731
Vistac No. 4	5.013	6.394	8.202

compounds suffered a change of 1.3%, whereas the observed changes were generally smaller than 1%; these data indicate good stability of the various grades of PIB. The data given in Table I were used for the preparation of the viscosity-temperature charts that were employed in the work with the bonding strength tester during 1951. It will be seen, in passing, that the various grades of paper involved in the work required a 20-fold range in viscosity.

It would, of course, be possible to employ a film of printing ink and, where special considerations or exigencies demand the use of an ink film, such a film should be used. However, the method of the IPC surface bonding strength tester has never rested on the idea of simulating a rotary printing press operation; the primary consideration has always been that a stress normal to a paper sheet might best be applied by means of a viscous film having Newtonian or at least reproducible rheological characteristics, for such a film, under the conditions of the test, cannot penetrate and modify the structure of paper (*1*). In this method, all variables of importance are maintained under accurate control; one of the disadvantages in the use of printing ink is that ink is variable in its mechanical properties.

In the early use of the method, the specimens were mounted on the specimen-carriers by means of diluted "3M" trim cement. Although such cement provides an almost perfect anchorage, the handling of the cement and cleanup were time consuming and unpleasant. In a search for more convenient methods it was found that "3M" double-faced pressure-sensitive paper tape (No. 400) is very effective and convenient. The specimen strips are first adhered to the "3M" tape, and then the combination is transferred to the specimen wheel 4 (Fig. 2). The tape, with the interlayer of creped paper, is pulled from the roll of tape, which in conveniently mounted with respect to a brass plate on which the specimen strips are joined. The brass plate is 5 by 34.5 in. (roughly the circumference of the specimen wheel), and it is probably important that its surface is not scoured or cleaned with a solvent, for the double-faced tape adheres to it only strongly enough for handling purposes. With the strip of creped interlayer paper still in place, the tape, under tension, is laid upon the brass plate. The interlayer paper is removed and the specimen strip, held under just sufficient tension to keep it taut, is laid in contact with the tape. The operator wears canvas gloves during these operations. If the specimen strips are of limited length, two or more strips are laid upon the tape in the region in which end-point observations are expected. The contacting ends of these strips are overlapped about $^1/_{16}$ in.; the order of overlapping is important, for the end of a strip which overlays the end of the next strip should be that end over which the film-carrying wheel rides last. In other words, the film-carrying wheel should meet a specimen strip by riding down upon it from the overlap, so that splitting of the paper may not be initiated from a free end. The direction of overlap is similar to that which would be involved in rolling a wheel down a shingled roof from the ridge pole toward the eaves. The remaining portions of the tape are covered by strips of any other kind of paper that is available in ready supply; again, there is overlapping of this masking paper over the "early" portion of the tape in the sense described above. This technique for working with short specimens is important, because long samples of paper are often not available; also, long samples are usually folded (instead of rolled), and an overlap should be employed instead of permitting the crease to remain in the tested region. Finally, the specimen is pressed against the adhesive tape by means of a 2-in. rubber-covered roll under firm loading (probably of the order of 50 to 70 lb.), and the combination is removed from the brass plate by lifting the right end of the tape vertically with a pull to the right. This causes the tape to separate from the brass plate with a minimum of flexing of the specimen. (One should be cautioned against pulling the right end toward the left—or vice versa—because this would flex the specimen unduly and probably modify the bonding strength of the paper much in the way the characteristics of a paper web may be changed by running it over a bar.) With the combination of tape and specimen held in slight tension, it is transferred to the specimen wheel in the proper sense with regard to the overlaps and with the "early" end of the tape joined to the specimen wheel in roughly the correct position. (With the apparatus in the cocked position, the film-carrying wheel leaves a characteristic mark which is later used as the zero point for measurements along the strip.)

In the testing of all papers excepting occasional, very well-bonded paper, the double-faced tape adheres more than sufficiently strongly to prohibit separation between the specimen wheel and the tape. This conclusion was arrived at through the use of ordinary inspection and also with the help of photographs taken with the Institute's microflash equipment (exposure time about 5 microsec.) at various stages of actual runs. However, at very high values of the VVP, separation may occur between the specimen wheel and the adhesive tape. In this situation, the bond is improved by the application to the steel wheel of a very thin layer of "3M" trim cement, formed from a dilute solution of the cement in petroleum ether. It should be mentioned that separation between the tape and the specimen wheel causes the apparent VVP to be erroneously low, probably because the specimen is then pulled away from the viscous film in an abnormally sharp manner, resulting in stress concentration.

After removal from the specimen wheel, the specimen is handled and examined in the manner described in the following section; after this, the combination of tape and specimen is transferred to a large sheet of corrugated paperboard, for measurement of distances from the zero point to the marked end points, and for storage and later reference.

After removing the combination of tape and specimen from the apparatus, the specimen is first examined for such evidences of early failure as small blisters and minute picking. Blisters are often not seen unless the operator holds the strip in the two hands in such manner that the tape and strip are bent with the paper specimen on the concave side; these evidences of internal failure are then readily seen, especially if nearly grazing light is used for illumination. If desired, the paper surface may be inspected with the aid of a low-magnification binocular microscope. The point at which general rupture of the paper begins is, of course, easily seen. All positions on the paper are marked prior to mounting on

the corrugated paperboard, so that distances may subsequently be measured to all the points of interest.

Influence of Contaminations

The results of earlier studies on instrumental and procedural variables were regarded as of doubtful validity and were discarded when it was discovered that the VVP is very sensitive to fingerprints. Without doubt, other contaminants would create error and, hence, paper to be tested for bonding strength by this method should be handled as little as possible and then only with gloved hands; care should also be exercised to protect the surfaces from contaminants of any nature. This sensitivity is not regarded as a drawback of the method, for there is every reason to believe that contaminants would have similar effects in actual printing operations.

In an investigation of the effect, paper strips were cut from the same sheet (in one case, newsprint; in another, coated paper). In the handling of one set, the operator wore canvas gloves, and touched the paper as little as possible. In other sets, the strips were deliberately touched with freshly washed bare fingers and, in some cases, the oil from the skin was augmented by first rubbing the finger against the side of the nose. In the case of fingerprinted strips, the failure of the paper was inhibited wherever there were prints, at points far beyond the normal location of the onset of general rupture of the paper. In one case, where the prints were applied at intervals, failure was observed only in the zones between the prints; apparently, failure would begin in such a zone and stop when the film-carrying wheel encountered a fingerprint; then the failure would begin again in the next zone between prints, and so on, until the failure became so strong (with the VVP about 22% higher than normal) that general and continuous rupture eventually set in. The effect was shown not to be due to a local change in moisture content of the paper, and it seems plausible that the slight amount of oil from the skin reduces the stress transmission in the series of links: PIB—skin oil—paper.

Influence of Specimen Backing

There are at least two reasons for believing that the nature of the specimen backing should influence the observed value of the VVP. First, if the paper is very smooth (as in the case of a supercalendered coated paper) a very thin backing provides virtually no cushioning and the viscous film should meet the paper in a uniformly wetted zone of minimum circumferential width, whereas a thick backing should result in a wide zone. In the absence of a complete analytical theory for the stresses developed in the viscous film, it is not yet possible to say what, from a theoretical viewpoint, should be the influence on the VVP of an increase in the width of the wetted zone, but an influence of some sort is expected. Second, for a given over-all compressibility of the combination of the specimen and backing, one would expect that the completeness of wetting of the contacted surface would depend upon the smoothness of the paper. Since the width of the wetted zone is narrower when a thinner backing is used, one would then expect a greater pressure of the film upon the paper surface. As a result, it would be expected that the effect of smoothness (possibly noticeable only in the case of rougher papers) would be to cause the observed VVP to diminish with decreasing backing thickness. This effect would depend upon the thickness of the viscous film and upon the loading of the film-carrying wheel (see later sections). Unless otherwise stated, the work discussed in the present report was done with a film thickness of 0.001 in. and a loading of 133 lb. per linear in.

The following backings were used in an investigation of the influence of the thickness of compressible backing material. (1) A very thin film of "3M" trim cement only. This was formed on the specimen wheel by rotating this wheel in a trough containing a dilute solution of trim cement in petroleum ether and toluene, the degree of dilution being such as to result in a thin, uniform film. The film was permitted nearly to dry before applying a paper specimen, so that there would be no "strike-in" of the adhesive into the paper. This film was so thin that the compressibility of the layer of paper and backing was essentially that of the paper alone. (2) A single layer of "3M" No. 666 double-faced pressure-sensitive cellophane tape. This tape is substantially thinner than the No. 400 double-faced paper tape normally used. (3) A single layer of the No. 400 double-faced paper tape. (4) Two layers of No. 400 tape. (5) Three layers of No. 400 tape. This last backing is, of course, quite thick and compressible. For the papers employed in this portion of the work—a supercalendered off-machine coated paper, two newsprints, and a 100% rag bond paper—all these backings adhered more than sufficiently well to withstand the disruptive stress in the testing.

The observations for two end points are given in Table II. "Complete rupture" corresponds to a general lifting of a film of paper from the body of the sheet, with the lifted film remaining on the sheet, but torn down the middle of the ruptured zone; at a somewhat higher VVP, a film of paper is completely removed from the sheet and is found after the run on the film-carrying wheel. "Blister" failure is, as the name suggests, the result of failure within the sheet—in small, oval, and elongate zones. The blister films are intact and often (as previously mentioned) may be seen only while holding the combination of tape and specimen in such manner that the specimen is on the concave side of a bent portion, in light which nearly grazes the specimen surface. Further along the strip in the direction of increasing VVP, one sees blisters which increase in size and number until the point designated as "complete rupture" is reached.

The first conclusion to draw from an inspection of the data given in Table II is that, in consideration of the large relative range covered by the backings, there is only a weak dependence of the VVP on the backing. With two exceptions, which occurred when the backing was changed from trim cement to a single layer of the double-faced cellophane tape, there appears to be a slow decrease in the VVP with increasing thickness (and compressibility) of the backing. The choice of a single layer of "3M" Tape No. 400 for regular use appears to be well justified by the data. It will be seen that any error in the VVP resulting from variability of the thickness of the adhesive tape would be completely negligible.

The earlier failure of paper, occurring when the backing is more compressible (i.e., smaller VVP), might

Table II. Effect of Specimen Backing

Type of failure	Backing	Coated paper (VVP), kp. cm./sec.	Newsprint A (VVP), kp. cm./sec.	Newsprint B (VVP), kp. cm./sec.	100% rag bond (VVP), kp. cm./sec.
Complete rupture	Trim cement	93.3	92.6	160	612
Complete repture	Tape No. 666	89.3	128	224	595[a]
Complete rupture	Tape No. 400	93.0	119	219	562
Complete rupture	2 layers 400	81.4	122	207	536
Complete rupture	3 layers 400	76.2	118	202	557
Blister	Tape No. 666	53.0	74.7	143	235[a]
Blister	Tape No. 400	...	70.9	140	253
Blister	2 layers 400	27.5	...	132	263
Blister	3 layers 400	29.5	...	115	232

[a] Single determination. All other data are the averages of at least six determinations.

possibly be the result of a sharper pull-away of the paper from the viscous film owing to the greater deformation of the combination of paper and backing, in a manner mechanically similar to the adverse effect on the VVP of the failure of bond between the specimen and the specimen wheel (see the section on "Method of Mounting the Specimen," second paragraph).

Effect of Load on the Film-Carrying Wheel

Data obtained in earlier studies, which had been invalidated by the discovery of errors resulting from faulty techniques uncovered in the preliminary phases of the present work, showed that the observed VVP varied only slowly with the mechanical load on the viscous film. In a further check of the effect, a series of careful determinations were made, using a coated paper

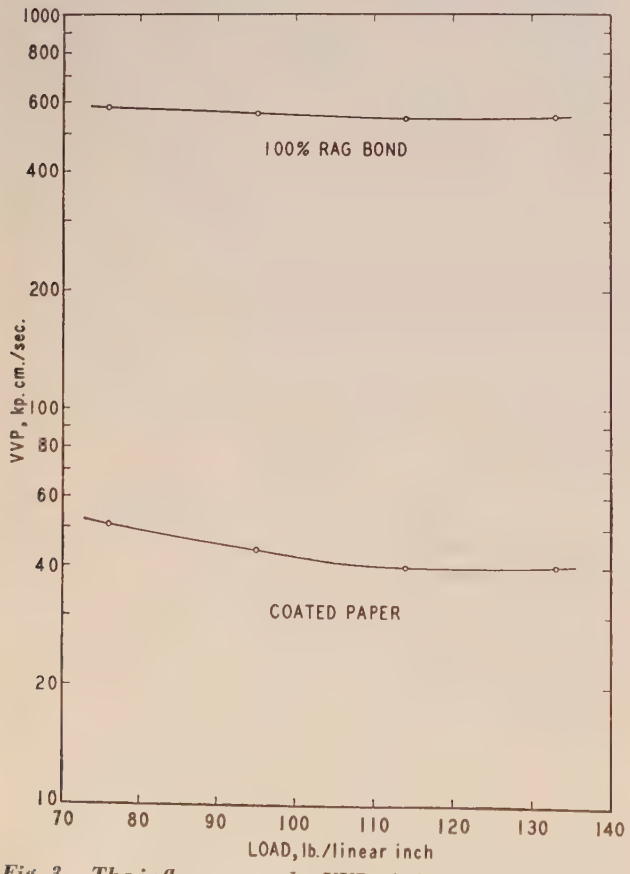

Fig. 3. The influence on the VVP of the load on the film-carrying wheel 2 (see Figs. 1 and 2)

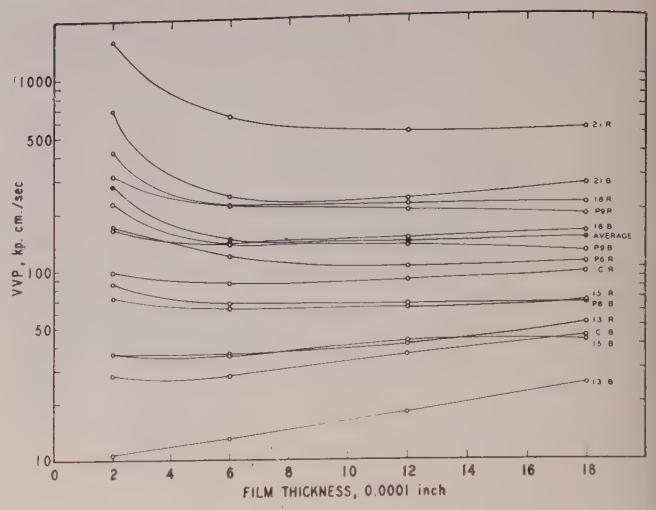

Fig. 4. The influence on the VVP of the thickness of the viscous film on the film-carrying wheel

The letter following the code designation indicates whether the end point was blister (B) or complete rupture (R). P6 newsprint; P9 newsprint; 13, coated paper (12% casein); 15 coated paper (16% casein); 18 coating raw stock, surface treated with starch; 21, 100% rag bond; C, commercial coated paper.

(representative of low VVP) and a 100% rag bond paper (representative of a high VVP).

The load on the film-carrying wheel may be varied by changing the weights (27) (Fig. 1). Runs were made with loads of 76, 95, 114, and 133 lb. per linear in.; the actual loads, in pounds, on the film-carrying wheel, which is $^1/_2$ in. thick, were numerically half of these figures. The results of this check are presented in Fig. 3. It will be seen that there is only a weak dependence of the VVP on the mechanical loading and, in the neighborhood of 120 lb. per linear in., there is no dependence. The normal loading of 133 lb. per linear in. was selected in consideration of three operational factors: (1) In the testing of a series of laboratory handsheets which had extraordinarily high VVP, it was observed that imperfect wetting of the specimens occurred at the higher speeds when the load was appreciably smaller than 133 lb. per linear in.; (2) the curves giving VVP versus load are almost flat at this loading; and (3) this loading is easily achieved with the existing system of weights (27, Fig. 1).

The weak dependence of the VVP on loading would seem to be of theoretical interest. If the tension stress in the viscous film (negative pressure) which is responsible for the disruption of the paper existed over an appreciable peripheral area in the rear or trailing portion of the nip, one would expect that an increase in load on the film-carrying wheel should cause an observed increase in the VVP, for such an increase in load should increase the (positive) hydrostatic pressure in the film. Of course, whether or not such an expected trend could be observed would depend upon the relative values of the increment of the hydrostatic pressure and the negative pressure required to disrupt the paper. The hydrostatic pressure resulting from the loading is estimated to be of the order of 500 p.s.i. An exact value for the tensile strength of paper in a direction normal to the plane of the sheet is not known because of strong imperfections of the commonly employed method for evaluating it (4), but it is supposedly of the order of 100 to 1000 p.s.i.; therefore, the mechanical loading in-

Table III. Comparison of VVP with the Performance of Coated Papers

Sample	Type	Commercial printing procedure	Comment on performance	VVP type of failure		
				Blister	Coating	Body stock
1a	Coated cover, 133 lb.	Sheet-fed letterpress	Heavy split	Low[a]	21.3	29.4
1b	Similar	Same	OK	Low[a]	37.6	53.0
2a	Coated mag. cover, 80 lb.	Claybourne high-speed, 5-color, sheet-fed press	Picked	41.3	51.1	79.1
2b	Coated mag. cover, 85 lb.		OK	28.0	48.8	93.3
3a	Coated cover	Sheet-fed letterpress	Picked	<11.9	21.6	38.6
3b	Similar	Same	OK	<13.4	42.3	69.9
4a	Coated book	Sheet-fed letterpress	Picked	14.3	33.0	40.3
4b	Similar	Same	OK	41.4	67.1	104
5a	Coated mag. cover, 85 lb.	Cottrell high-speed, 4-color, sheet-fed press	Picked[b]	75.7	79.5	114
5b	Coated mag. cover, 75 lb.		OK	37.6	57.0	97.2
6	Coated cover, 146 lb.	Sheet-fed letterpress	Slight pick	Low[a]	27.5	33.2
7	Coated cover, 130 lb.	Miehle letterpress, slow-speed	Picked	Low[a]	19.3	26.3
8	Coated cover, 146 lb.	Sheet-fed letterpress	Heavy pick and split	Low[a]	20.3	28.6
9	Coated mag. cover, 80 lb.	Claybourne high-speed, 5-color, sheet-fed press	OK	23.0	56.1	67.9
10	Coated mag. cover, 95 lb.	Cottrell high-speed, 8-color, web-fed	OK	24.5	57.7	90.7
11	Coated mag. cover, 95 lb.	Cottrell high-speed, 8-color, web-fed	OK	33.6	47.6	72.7
12	Coated book, 80 lb.	Sheet-fed letterpress	Slight pick	Low[a]	30.6	34.6
13	Coated offset, 60 lb.	Webendorfer, 10,000 imp./hr. 4-color, sheet-fed	OK	43.5	78.9	92.8
14	Coated offset, 80 lb.	Offset	OK	<16.8	66.0	74.9
15	Coated offset, 80 lb.	Offset	OK	24.7	57.3	77.8
16	Coated offset, 60 lb.	Offset	OK	43.9	77.9	86.8
17	Coated offset, 55 lb.	Offset	OK	53.1	96.1	105

[a] Below range for limited sample available.
[b] But OK when the ink was thinned.

volved in the present study should not be negligible in its effect. In view of these considerations, it would seem that the disruption of the paper in the bonding strength tester is caused by a tensile stress in the viscous film in a *very narrow zone at the trailing edge of the zone of contact or possibly slightly beyond the load-bearing zone of contact* (possibly immediately adjacent to the line of splitting of the film). If either of these alternatives is true, the slightly falling relationship between the VVP and the load, at light and intermediate loads, could be explained as the result of more complete wetting of the paper surface by the viscous film as the load is increased.

Influence of Thickness of the Viscous Film

By setting the film-forming tool at various values, films of thicknesses 0.00020, 0.00060, 0.0012, and 0.0018 in. were formed and, for each film thickness, the VVP values were obtained for a series of papers whose smoothness covered an appreciable range. Five determinations were made for each paper, for each film thickness; the averages of these determinations are presented in graphical form in Fig. 4. In each case, two end points were determined: first, the VVP corresponding to blisters was observed (designated in Fig. 4 as "B") and, second, the VVP corresponding to complete rupture was noted (designated as "R").

It will be seen that, generally, there is only a weak dependence of the VVP on the film thickness for the range in thickness, 0.00060 to 0.0018 in. In most cases a minimum (at which a small variation in film thickness should produce no appreciable error in the VVP) is displayed. The film thickness adopted for general work (0.0010 in.) is justified by the data given in Fig. 4. In the least favorable case (blister end point, sample 13), a 10% error in the application of a viscous film of this thickness would give rise to an error of only 5%; in all the other cases the error would be less than 3%.

The fairly sharp rise exhibited by some of the curves corresponding to the reduction in thickness from 0.00060 to 0.00020 in. may best be understood by observing the paper specimens after testing with the thinner film. At a film thickness of only 0.00020 in., the surface irregularities of paper are such that only incomplete wetting and anchorage are obtained. Accordingly, to produce blistering and picking of the surface, the velocity must be greater, which results in a greater VVP. In certain instances the surfaces were sufficiently smooth to result in only a mild rise in the VVP, or to exhibit a continuation of the downward trend. At great film thicknesses, it is expected that the primary concern would be with lessened traction stress resulting from a reduced rate of shear owing to increased film thickness; this, in turn, would necessitate a greater velocity to produce rupture in the paper, thus accounting for the upward trend of the VVP-film thickness curves. Of course, as the film thickness becomes greater, the squeeze-out effect becomes more appreciable, and the effective film thickness becomes progressively less than the intended thickness. This effect, which is not viewed as being of importance at 0.0010 in., would tend to account for some of the flatness of the curves of Fig. 4, in the region of greater film thickness.

Disregarding the results for a film thickness of 0.00020 in. (as being too dependent on paper smoothness), the data given in Fig. 4 suggest that, if many papers were tested, the curves would cross each other here and there (because the slopes are different). In consequence, the ranking of a series of papers with regard to bonding strength for a film thickness of, say, 0.00060 in. would not be the same as that for a substantially different thickness such as 0.0018 in. Since both rankings cannot be correct, and there seems to be no objective means for selecting a "correct" thickness, the VVP as measured cannot be exact; other variables are involved. It seems likely that, of the secondary variables, smoothness of the paper would be of considerable importance. If this is true, then the crossing of curves would be most severe where one is concerned with a miscellaneous

collection of papers (such as those selected for the film-thickness study) having smoothness varying from that of supercalendered coated paper to that of a bond paper, and the reliability of ranking of a series of papers of the same type (e.g., a given grade of offset paper) would be better than that indicated by the array of curves given in Fig. 4.

In studies where the VVP is regarded as a measure of bonding strength, one is interested in the constancy of any functional relationship that may exist between the VVP and the bonding strength. If, for example, it developed that the VVP were directly proportional to the bonding strength, one would be concerned with the error in the "constant" of proportionality. On the basis of variability of slope of the curves of Fig. 4 in the region of the minima, it appears that the error in the "constant" could at times be at least 60%. Thus, in studies where the interest lies in measuring the true bonding strength of paper in terms of arbitrary units, as contrasted with investigations in which one is interested in the relative resistances of papers of similar grade and structure to picking, blistering, etc., the VVP should not be regarded as an *accurate* measure of bonding strength. It may prove to be a *precise* measure of this property.

CORRELATIVE STUDIES

There is, of course, considerable interest in the matter of whether the VVP correlates with the performance of paper, with regard to blistering, picking, and splitting, in commercial printing operations. An accurate correlative study may not be made because of the lack of control of important variables in the pressroom. The mechanical stresses resulting in picking during a printing operation arise in a manner which is evidently closely similar to that in which stresses are generated in the bonding strength tester. Thus, a change in character of the ink could result in a substantial increase in the viscosity of the ink and picking may result; or a decrease in the viscosity might result in satisfactory performance—even when the paper is below par in its resistance to picking. A relatively small drop in the temperature of the pressroom could result in a substantial rise in the viscosity of the ink and picking might result. Although the speed of a press is one of the few variables which may be well controlled, an increment in the speed would result in an increase in the viscosity-velocity product of the printing operation. The relative humidity of the air in pressrooms is usually not controlled and, in one long run, the relative humidity varied from 6 to 99%! In view of considerations such as these, one may not expect to find an accurate relationship between performance in commercial printing and the VVP.

In spite of the inherent impossibility of obtaining an accurate comparison between pressroom performance and instrumental evaluation of the pick resistance of paper, it was thought to be desirable to carry out a limited study, involving a series of 22 commercial coated papers of reported behavior on presses. The results are given in Table III. The comments on the pressroom performance are given in column four, and the data on VVP are presented in the last three columns. Certain of the "blister" failures (column five) could not be obtained because it was desirable to run five test strips from each sample, and ther was insufficient usable material for the extra runs with PIB of low viscosity to observe the onset of blistering; "Low" means that blistering occurred at the "early" end of the test strips and, hence, that the VVP was too small to be measurable. The data given in column six are for a coating pick which was detected with the aid of a low-power binocular microscope; the data in this column are the averages of the VVP corresponding to the earliest evidences of slight coating pick. These data are, therefore, subject to substantial statistical fluctuation. The results presented in the last column are for an end point corresponding to general rupturing and, of the data presented in the last three columns, are felt to be the most reliable.

Certain pairs of papers (those designated 1a and 1b through 5a and 5b) were printed at about the same time on the same equipment. In each case but one, the paper which performed with a rating of "OK" had the higher VVP for rupture or body stock failure (last column). In the exceptional case, the ink was thinned to obtain satisfactory performance, and the presumption is that sample 5b was printed with the thinned ink. This exceptional case is interesting, because the VVP for sample 5a was the highest (for all three end points) observed in the series. Perhaps this case illustrates the uncertainties of pressroom performance ratings, for this paper possessed good bonding strength.

Because of the absence of the comparative aspect in the remaining 12 papers, the results are only of very qualitative interest. Considering the information for all the papers, it may be concluded that there is some correlation between the pressroom performance and the VVP—perhaps as good as could be expected, even if there were a perfect relationship between the VVP and the behavior of paper on a press under idealized conditions of control. With regard to the data on the "blister" end point, all papers but one having a small VVP picked to some degree. Two papers (one already discussed) having moderate to high VVP were reported to have picked. However, some rated as "OK" had low VVP. Similar comments may be made for the data based on the observations of coating pick made with the binocular microscope. With regard to the data presented in the last column, the papers having a rating of "OK" have VVP above 50 kp. cm. per sec. Excepting, as before, samples 2a and 5a, all papers having a VVP (based on body stock rupture) less than 41 kp. cm. per sec. picked. The two papers which were reported to have split heavily (samples 1a and 8) had very low VVP — only 29.4 and 28.6 kp. cm. per sec.

LITERATURE CITED

1. Instrumentation Studies. LV. *Paper Trade J.* 123, No. 18: 24, 26, 28–29; No. 19: 24, 26, 28, 30, 32, 34 (Oct. 31, Nov. 7, 1946). Based on Report 31, Part III, to the American Paper and Pulp Association (March 23, 1942).
2. The Institute of Paper Chemistry. Testing Methods for Printability of Newsprint. Progress Report Three. The New IPC Surface Bonding Strength Tester. American Newspaper Publishers Association, *Research Bulletin* 34 (Oct. 17, 1950).
3. Thickens, R. W. Capacitance-Change Viscometer. *Electronics* 24, No. 4: 116–117 (April, 1951). The data obtained with this device are to be published soon.
4. The Institute of Paper Chemistry. Report No. 41 to the American Paper and Pulp Association. General Discussion of the Measurement of Adhesion and Cohesion (Feb. 15, 1945). Instrumentation Studies. LXIX. *Tappi* 35, No. 4: 155 A–162 A (April, 1952).

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Seventh Engineering Conference, Morrison Hotel, Chicago, Ill., October 13–16, 1952.

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Plastics Conference, College of Forestry, State University of New York, Syracuse, N. Y., November 5–6, 1952.

Alkaline Pulping Conference, Battle House, Mobile, Ala., November 12–14, 1952.

Corrugated Containers Conference, Schroeder Hotel, Milwaukee, Wis., November 20–21, 1952.

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INDEX TO ADVERTISERS

Allis Co., Louis	33 A
Allis-Chalmers Mfg. Co.	63 A
American Brass Co.	95 A
American Cyanamid Co. (Industrial)	11 A
American Key Products, Inc.	101 A
Anheuser-Busch, Inc.	64 A
Ansul Chemical Co.	120 A
Antara Chemicals Div. (General Dyestuff Corp.)	47 A
Appleton Machine Co.	89 A
Appleton Wire Works, Inc.	8 A
Arabol Mfg. Co.	126 A
Armstrong Machine Works	107 A
Asten-Hill Mfg. Co.	29 A
Babcock & Wilcox Co.	25 A
Bauer Bros. Co., The	10 A
Beloit Iron Works	1 A
Bird Machine Co.	73 A
Back-Clawson (Shartle & Dilts)	60 A
Brown Co.	7 A
Buckman Laboratories, Inc.	4th Cover
Buffalo Electro-Chemical Co., Inc.	21 A
Butterworth & Son, H. W.	153 A
Cambridge Instrument Co., Inc.	122 A
Chicago Bridge & Iron Co.	12 A
Cleary Corp., W. A.	121 A
Combustion Engineering-Superheater, Inc.	83 A
Corn Products Sales Co.	116 A
Cowles Co , Inc., The	115 A
Crosby Chemicals, Inc.	105 A
Curlator Corp.	75 A
Denver Equipment Co.	37 A
Dorr Co.	79 A
Dow Corning Corp.	190 A
Draper Brothers Co.	175 A
Du Pont de Nemours & Co., E. I. (Grasselli-Quilon)	9 A
Du Pont de Nemours & Co., E. I. (Grasselli-Lignasan X)	43 A
Du Pont de Nemours & Co., E. I. (Electrochemicals)	61 A
Du Pont de Nemours & Co., E. I. (Pigments Dept.)	35 A
Earl Paint Corp.	103 A
Eastwood-Nealley Corp.	13 A
Ebasco Services, Inc.	118 A
Egan & Co., Frank W.	81 A
Farrel-Birmingham Co., Inc.	27 A
Foxboro Co.	58 A
General American Transportation Corp.	68 A
General Dyestuff Corp.	69 A
Goodyear Tire & Rubber Co., Inc. (Chemical Div.)	3 A
Goslin-Birmingham Mfg. Co.	114 A
Gottesman & Co.	77 A
Graton & Knight Co.	70 A
Gurley, W. & L. E.	125 A
Heppenstall Co.	39 A
Hercules Powder Co.	2nd Cover
Hermann Manufacturing Co.	34 A
Hooker Electrochemical Co.	31 A
Hubinger Co., The	113 A
Huffman-Wolfe Co.	97 A
Ingersoll-Rand Company	117 A
International Nickel Co.	91 A
Jackson & Church	57 A
Johns-Manville Corp. (Celite)	65 A
Jones & Sons, E. D.	49 A
Kelco Co.	51 A
Lindsay Wire Weaving Co.	99 A
Lukenweld Div. (Lukens Steel Co.)	36 A
Magnus Chemical Co.	118 A
Mallinckrodt Chemical Works	125 A
Mathieson Chemical Corp.	38 A
Michigan Steel Casting Co. (Alloy Casting Div.)	109 A
Midwest-Fulton Machine Co., The	122 A
Monsanto Chemical Co. (Merrimac Div.)	55 A
Murray Mfg. Co., D. J.	124 A
Nopco Chemical Co.	2 A
Ohio Injector Co.	45 A
Oliver United Filters, Inc.	87 A
Orr Felt & Blanket Co.	123 A
Pandia, Inc.	93 A
Perkins & Son, Inc., B. F.	127 A
Philadelphia Quartz Co.	76 A
Pusey & Jones Corp.	52 A–53 A
Reichhold Chemicals, Inc.	41 A
Rice Barton Corp.	19 A
Rohm & Haas Co.	3rd Cover
Sindar Corp.	112 A
Solvay Process Div. (Allied Chem. & Dye Corp.)	6 A
Sprout-Waldron & Co., Inc.	66 A
Staley Mfg. Co., A. E.	59 A
Sutherland Refiner Corp.	17 A
Swenson Evaporator Co. (Whiting Corp.)	46 A
Taylor-Stiles & Co.	56 A
Tennessee Corp.	127 A
Torrington Co., The (Bantam Bearings Div.)	4 A
Trundle Associates, Inc.	111 A
U. S. Stoneware Co.	126 A
Vanderbilt Co., Inc., R. T.	15 A
Wallace & Tiernan Co., Inc.	62 A
Wallerstein Co.	124 A
Warwick Wax Co.	67 A
Westinghouse Electric Corp.	22 A–23 A
Wyandotte Chemicals Corp.	85 A

PROFESSIONAL SERVICES

American Defibrator, Inc.	189 A
Chemical Linings, Inc.	189 A
Chicago Testing Laboratory	189 A
H. K. Ferguson Co.	189 A
Gilbert Associates	189 A
G. E. Jenssen Co., Inc.	189 A
Knowles Associates	189 A
Chas. T. Main, Inc.	189 A
Myers & Addington	189 A
Roderick O'Donoghue	189 A
Paper and Pulp Testing Laboratories	189 A
Pfeifer & Schultz	189 A
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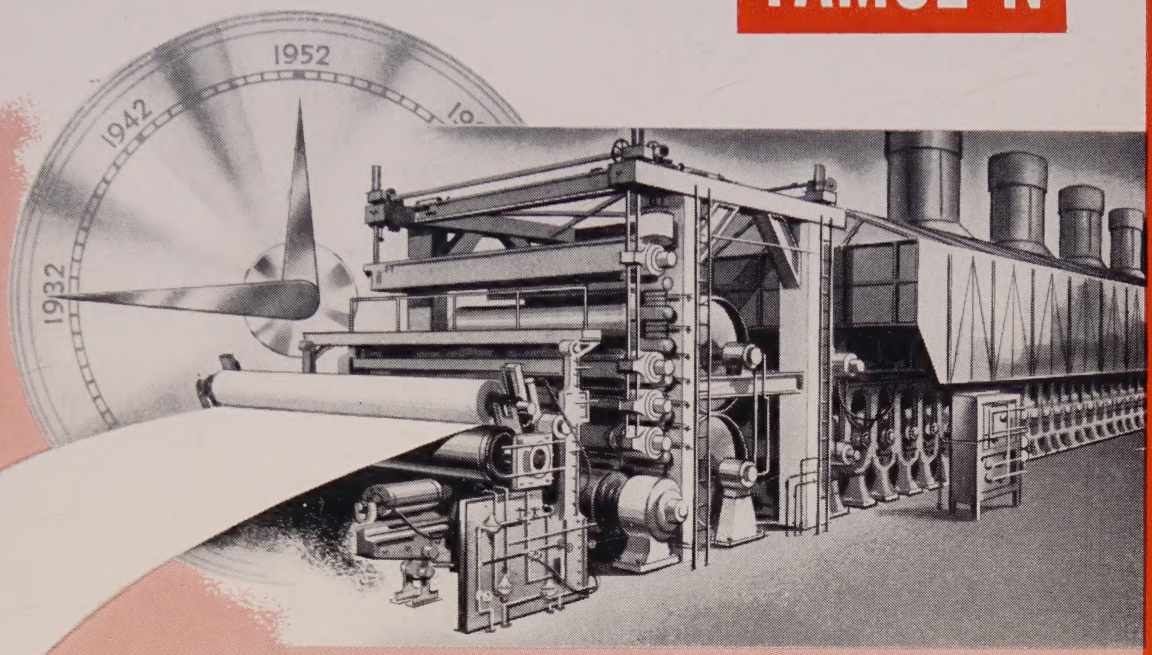

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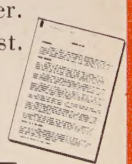

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